Essays in competition with product differentiation and bargaining in markets

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Preface

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Contents

Preface v

Contents vii

1 General Introduction 1

1.1 The Partial Equilibrium Approach and Consumer Surplus. . . . 2

1.2 Price Competition. 4

1.3 The Economics of Product Differentiation. 5

1.3.1 Horizontal and Vertical Product Differentiation. 6

1.3.2 Monopolistic Competition: Localized and Non-localized Competition. 12

1.3.3 Summary of the Essays with Product Differentiation . . 15

1.4 Price Commitment and Bargaining in Markets. 17

1.4.1 Summary of Essay on Bargaining in Markets 20

References 22

2 Phonebanking 25

2.1 Introduction 25

2.2 A Model of Spatial Phonebanking Competition on the Circle. . 27

2.3 Solution of the Game. 30

2.3.1 Second Stage Competition: The Choice of Interest Rates. 30

2.3.2 First Stage Competition: Phone Option Decision. 37

2.3.3 Collusion, Fees, and Multiproduct Banks. 41

2.4 Concluding Remarks. 42

References 43

3 Monopolistic Competition with a Mail Order Business **45**

3.1 Introduction 45
3.2 The Model 49
3.3 Monopoly 50
3.4 Oligopoly 52
3.5 Free-Entry Equilibrium 60
3.6 Welfare Analysis 65
3.7 Conclusion 68
3.8 Appendix 69
References 70

4 Price Competition between an Expert and a Non-expert **73**

4.1 Introduction 73
4.2 The Model 76
4.3 Demand Analysis 78
4.4 Equilibrium Analysis 80
4.5 Welfare 92
4.6 Concluding Remarks 95
4.7 Appendix 97
References 100

5 Bargaining in Markets with Simultaneous and Sequential Suppliers **101**

5.1 Introduction 101
5.2 The Model 104
5.3 The 'Random'-market 106
5.4 The *FIFO*-market 110
5.5 Stability of Market Organization 113
5.6 Conclusion 122
References 125

Summary in Dutch **127**

Chapter 1

General Introduction

This dissertation contains four essays in economics with imperfect competition. Each of these essays is self-contained and can be read separately. At first glance, they seem to be completely unrelated to one other. This General Introduction points out the main methodological relationships between the essays. It also offers the reader a compact background of the related literature, explains its main issues, and provides a short list of its most important results. Finally, it contains a short summary of the essays of the dissertation.

To begin with the methodological similarities, all essays adopt the *partial equilibrium* approach. That is, a consumer's welfare is well-captured by the notion of *consumer surplus.* In other words, the essays assume that there are no income-effects. Second, essays one to three deal with imperfect competition and differentiated products. Use will be made of two well-known models in the spatial-differentiation tradition: the linear model and the circular model. These two models allow to formally analyze the concepts of product differentiation. Essays one and three combine the concepts of *horizontal* and *vertical* product differentiation. Essay two, however, only treats horizontal differentiation. In contrast with essays one and three, the second essay focuses on *monopolistic competition.* In addition, it combines *localized* and *non-localized* competition.

There are, however, also some methodological differences between the four essays. First, essays one to three use *non-cooperative* solution concepts, while essay four makes use of a *cooperative* solution concept. Second, although all essays deal with *price competition*, essays one to three presume *price commitment* while essay four takes a *bargaining* approach. In other words, the essays with price commitment assume that the sellers make a take-it-or-leave-it offer. Hence, consumers have no bargaining power. Essay four, by contrast, treats sellers and consumers symmetrically in that both are given the same amount of bargaining power.

Section **1.1** of this General Introduction discusses the partial equilibrium approach and the notion of consumer surplus as a measure for the consumer's welfare. A short motivation for models with price competition is given in Section **1.2**. The two strands of literature in the economics of product differentiation are treated quite extensively in Section **1.3**. At the end of that section, the set-ups and central results of essays one to three are presented. Section **1.4** discusses the differences between price commitment and negotiated pricing, addresses the main issues of bargaining in markets, and highlights the essential differences between the cooperative and non-cooperative bargaining approach. That last section also contains the set-up and main insights of the fourth essay.

1.1 The Partial Equilibrium Approach and Consumer Surplus.

General Equilibrium Theory studies the interdependencies between markets in an economy. It takes all prices in the economy as variables. In a Walrasian equilibrium, it is required that prices clear all markets. That is, in such an equilibrium, the value of the excess demand equals zero. General Equilibrium Theory proves useful in examining how a change in one market leads to a new general equilibrium in *all* markets: an increase in the tax on labor may positively effect demand in the market for capital; an increase in the tax on the net income of corporations may well have a negative effect on the return on investment in the non-corporate sector. The message of general equilibrium theory is clear: ignoring the effects of a change in one market to other markets may imply incorrect conclusions and, therefore, be misleading.

Partial Equilibrium Analysis, in contrast, offers a single-market approach in that a good is singled out while ignoring any interaction with the rest of the economy. The partial equilibrium approach has its merits in examining problems when the effect of a price increase, say on staples, only negligibly affects demand for other goods: although the price increase reduces the demand for staples, its effects on other goods are spread almost evenly. By consequence, wage rates, return on capital, and consumption patterns are only negligibly affected. The message of partial equilibrium analysis is equally clear: when a price change in one market only negligibly affects the demand for other goods, the marginal benefits of a general equilibrium analysis not necessarily outweigh its marginal costs. In that case, the partial equilibrium approach may offer a good approximation of the problem at hand. The simplifying partial equilibrium analysis also allows to incorporate elements that may increase the degree of *realism* of the model.

Economists are not only interested in how markets are related to each other (general equilibrium) or how these function in isolation (partial equilibrium). That is, they are not only concerned with *positive analysis*. They are also interested in how the effect of a price change affects consumer welfare and producer profits. An appropriate measure for welfare change determines whether the price change should be carried out or not. In other words, economists are also interested in *normative analysis*. In partial equilibrium analysis, the effect of a price change on consumer's welfare is typically measured by the *(Marshallian) consumer surplus*. That is, a monetary measure defined by the area to the left of the (Marshallian) *demand function* between two prices. This demand function depends on prices and income. It is important to mention that this way of measuring the change in the consumer's welfare only makes sense under specific conditions. In particular, this measure for the change in the consumer's welfare is appropriate when there are no income-effects. This is the case when (i) income is sufficiently high, and (ii) the rest of the economy can be treated as an aggregate numéraire that linearly enters the consumer's utility. In other words, the price change only affects the demand for that particular good and can, therefore, be analysed in isolation.

This dissertation takes the partial equilibrium approach and ignores any income effects. The conclusions, therefore, should be interpreted from a perspective where the goods purchased only constitute a small fraction of the total income level. That is, small price changes will have (almost) no effect on the demand for other goods.

1.2 Price Competition.

In the Walrasian competitive framework the economic agents are price takers. This framework, however, does not explicitly model how the economic agents interact. The formation of prices is not modelled as a result of some interaction between these economic agents. Rather, markets are the level of analysis. As a *deus ex machina*, the Walrasian auctioneer clears the markets by equating demand and supply. Cournot (1838) proposed a model where sellers interact with each other. With quantities as the strategic variable, each firm maximizes its profit given the quantities chosen by all other firms. Still, an auctioneer has to determine the market clearing price. Bertrand (1883) criticized Cournot's model and claimed that the use of prices instead of quantities was strategically advantageous for firms. He argued that by charging a somewhat lower price than all other sellers, one single seller could attract the whole market. Bertrand's model allowed for an explicit treatment of interaction between the economic agents. In addition, there was no role anymore for a Walrasian auctioneer to determine the market clearing price. Finally, already with two price-setting firms whose marginal costs are identical and constant, Bertrand's model resulted in the competitive outcome. Bertrand's result has become known as *the Bertrand paradox*, for this result — that already with two firms, having identical and constant marginal costs, perfect competition emerges — seems too strongly to be taken as a "reasonable" way of modelling price competition between firms. Several ways out have been proposed by relaxing some of the assumptions in Bertrand's model. Edgeworth (1897) introduced the idea of capacity constraints. He concluded that for intermediate capacity constraints a price equilibrium in pure strategies does not exist. For small enough capacities and efficient rationing, however, the Bertrand approach coincides with the Cournot model. In other words, in some cases the Cournot model can be interpreted as a reduced form of a two-stage game where two firms choose their capacities in the first stage and compete in prices in the second stage. This has been shown by Kreps and Scheinkman (1983). Use of the Cournot model as a reduced form, however, must be made with caution as e.g. the staging of a game has important implications for the players' optimal strategies (see Tirole, 1988). Another way out of the Bertrand paradox is related to the aspect of time. Bertrand's model takes place in a timeless world. By allowing time to play a role in the modelling, repeated interaction between firms opens the possibility of an equilibrium with prices above marginal cost (see Fudenberg and Maskin, 1986). Finally, Bertrand's model is concerned with homogeneous goods. The introduction of differentiated goods, as we will see in the next section, softens the degree of competition and provides another way out of the Bertrand-paradox. Essays one to three of the dissertation use Bertrand-competition with differentiated products as a framework of analysis.

1.3 The Economics of Product Differentiation.

Essays one to three deal with topics in the economics of product differentiation. Products are said to be horizontally differentiated when at equal prices not all consumers necessarily rank the products in the same way. In contrast, with vertically differentiated products all consumers do rank products in the same way when their prices equal. Essays one to three make use of two well-known models in the economics of product differentiation: the linear and the circular model. The literature that has emerged out of these two models uses the framework of *spatial competition.* Within this paradigm, consumers as well as products can be regarded as points in some characteristics space (see Lancaster (1979) and Hotelling (1929)). The theory of spatial competition is mainly concerned with: (i) the strategic aspects of firms' product positioning in this characteristics space and (ii) price competition. The concepts of horizontal and vertical product differentiation are central in this literature. Since these concepts are used throughout essays one to three, Section **1.3.1** explains their meaning and highlights their different impact on the equilibrium market structure.

The second subfield has come to be known as *monopolistic competition.* Traditionally, it started off with Chamberlin's (1933) 'large-group' industry of *non-localized competition* where every firm directly competes in a symmetric fashion with all other firms. Kaldor (1935), however, criticized Chamberlin's idea and thought of *localized competition*: each firm only competes in a direct way with some but not all other firms. The study of this second subfield in the economics of product differentiation, however, does not focus on strategic aspects. It is mainly interested in whether a free market economy with differentiated products will offer the socially right number of product diversity. Essay two makes use of this framework and combines the idea of non-localized and localized competition. Section **1.3.2**, therefore, scans its most important issues. Section **1.3.3** offers a short summary of the horizontal and vertical differentiation set-up used in essays one to three. In addition, it also presents the main insights of these three essays.

1.3.1 Horizontal and Vertical Product Differentiation.

In Bertrand's (1883) model of price competition with homogeneous goods (see Section **1.2**), no firm can charge a price above marginal cost without losing its total market share: cross-price elasticities equal infinity at identical prices and zero at non-identical prices. Homogeneous goods, however, are more the exception than the rule. The picture changes drastically when products are differentiated. In Chamberlin's words:

> "A general class of product is differentiated if any significant basis exists for distinguishing the goods (or services) of one seller from those of another. Such a basis may be real or fancied, so long as it is of any importance whatever to buyers, and leads to a preference for one variety of the product to another. Where such differentiation exists, even though it be slight, buyers will be paired with sellers, not by chance and ad random (as under pure competition), but according to their preferences. Differentiation may be based upon certain characteristics of the product itself, such as exclusive patented features; trade marks; trade names; peculiarities of the package or container, if any; or singularity in quality; design, color, or style. It may also exist with respect to the conditions surrounding its sale. In retail trade, to take only one instance, these conditions include such factors as the convenience to the seller's location, the general tone or character of his establishment, his way of doing business, his reputation for fair dealing courtesy, efficiency, and all the personal links which attach his customers either to himself or to those employed by him. In so far as these and other intangible factors vary from seller to seller, the "product" in each case is different, for buyers take them into account, more or less, and may be regarded as purchasing them along with the commodity itself. When these two aspects of differentiation are held in mind it is evident that virtually all products are differentiated, at least slightly, and that, over a wide range of economic activity, differentiation is of considerable importance." (Chamberlin, 1933, pp. 56-57)

Hotelling was one of the first to systematically study the effects of physical and less tangible components of products on price competition. In his seminal paper, Hotelling (1929) recognized that

> "if a seller increases his price too far he will gradually lose business to his rivals, but does not lose all his trade instantly when he raises his price only a trifle. Many customers will still prefer to trade with him because they live nearer to his store than the others...or because he is a fellow Elk or Baptist, or on account of some differences in service or quality, or for a combination of reasons" (Hotelling, p. 44 and as quoted in Anderson, De Palma, and Thisse, 1992).

In Hotelling's model, consumers are uniformly distributed on some interval with unit length. There are two sellers who compete in prices. Each offers the same physical good; seller A has his store located at the left extreme of the interval while seller B has his location at the other extreme. Consumers derive some surplus from consuming the good. The distance between a seller's store and some consumer then has a natural interpretation. It represents the transportation cost a consumer incurs from going to the store. (In an alternative setting, the sellers' location defines the variant of some good and distance then represents the difference between the consumer's most favoured taste (his location) and the product's taste.) The distance, therefore, implies a loss in the consumer's utility. This loss together with the price of the good will determine whether a consumer prefers seller A to B or not. The cost of transportation clearly can be regarded as, in Chamberlin's words, something that is purchased along with the good. Thus, although the goods are physically identical, consumers regard the goods as differentiated because of this cost of transportation. The degree of differentiation increases with the cost of transportation. When this cost equals zero, goods are homogeneous and Bertrand's result appears. Hotelling's model concerns *horizontal product differentiation*: at equal prices consumers do not necessarily rank products in the same way; some prefer store A to store B while others rank the stores in the opposite way.

Hotelling also allowed the stores to *choose* their location (stage 1) before competing in prices (stage 2). The questions Hotelling tried to answer were: given each store's location, what prices constitute a situation in which no store can improve its profits given the other store's price. That is, what is the Nash equilibrium of the pricing-game. Having solved that problem, what choice of location could constitute a situation in which no store could improve its profit given the other's location. In other words, what is the (Subgame Perfect) equilibrium[1] of the location game. In more general terms, this is a two-stage game with observed actions[2]: firms simultaneously take an action in each stage. Knowing each other's choice of action of the first stage, each firm chooses an action in the second stage of the game. These models use the concept of Subgame Perfect equilibrium to solve the multi-stage game. This concept is due to Selten (1965, 1975), although authors such as Hotelling (1929) implicitly made use of it. It requires that the players should play according to a Nash equilibrium at *each* stage of the game. In a Nash equilibrium, no player finds it profitable to unilaterally deviate given the other players' actions. Hence, a Subgame Perfect equilibrium concept rules out that players make incredible threats.

The location choices influence not only the store's demand (the *demand* effect) but also the intensity of price competition: competition in price becomes more agressive when stores are located closer to each other (the *strategic* effect). Hotelling's analysis resulted in his famous "principle of minimum differentiation" in which the two stores choose exactly the same location. His analysis turned out to be incorrect as shown by d'Aspremont et al. (1979). They proved that with linear transportation costs, an equilibrium (in pure strategies) of the pricing-game does not exist when stores are located at non-identical and sufficiently close locations. In addition, they showed that with quadratic transportation costs the two stores locate at the two extremes of the unit interval, thereby establishing the "principle of maximal differentiation". This principle is the result of two opposing effects. The first effect moves the firm to the center in order to increase its demand (the demand effect). This movement, however,

[1] See below for more on this equilibrium concept.

[2] See Fudenberg and Tirole (1991).

enhances the degree of price competition (the strategic effect) as both firms become less and less differentiated from each other. With quadratic transportation costs, the strategic effect always dominates the demand effect. Therefore, both locate as far as possible from each other. The results of Hotelling's paradigm, therefore, heavily depend on the properties of the transportation costs (see Anderson, De Palma, and Thisse 1992).

In models with horizontal product differentiation, consumers do not rank the available products unanimously when sold at the same price. This need not always be the case. There is vertical product differentiation if heterogeneous consumers unanimously rank products at equal prices since all prefer higher to lower quality. Mussa and Rosen (1978) showed that a monopolist enlarges the quality spectrum as a device to discriminate consumers with a high willingness to pay for quality from others who value quality less. In an oligopolistic context, Gabszewicz and Thisse (1979, 1980) and Shaked and Sutton (1982) analysed how the market equilibrium would look like when firms offer vertically differentiated products. Shaked and Sutton (1982) use a multi-stage game where firms first choose whether to enter the market or not. In the second stage, they decide on quality. In the last stage, they compete in prices.[3] The unit cost of production is assumed to be constant and the level of quality is costless. On the consumers' side, consumers are ranked according to their 'taste for quality', and it is assumed that all consumers buy one of the available brands. In addition, consumers should be sufficiently heterogeneous with respect to their 'taste for quality': this guarantees the lowest quality firm a positive market share. Shaked and Sutton (1982) demonstrated that in a Subgame Perfect equilibrium, firms tend to differentiate themselves *maximally* from each other in order to relax price competition. In other words, the strategic effect dominates the demand effect. As a result, in equilibrium only two firms enter the market: one firm picks the highest quality while another selects the lowest quality. Consumers with a low (high) 'taste for quality' purchase from the low (high) quality firm.

[3]Shaked and Sutton's (1982) article is one of the first contributions on product differentiation, if not the first, that explicitly refers to Selten's (1975) equilibrium concept.

Two remarks should be made. First, the result of maximal differentiation is a direct result of the assumption that every consumer buys one unit. That is, the consumer with the lowest taste for quality should receive non-negative utility from purchasing the lowest quality good. If not, the low quality firm cannot serve any consumer, unless increasing its quality. Second, if there is no sufficient heterogeneity on the consumers' side, the low quality firm cannot locate herself far enough from the high quality firm. This leads to very tough price competition such that the low quality firm cannot attract any demand. The high quality firm, however, charges a price above marginal cost and makes positive profits. In other words, the principle of differentiation is a robust result. This is in sharp contrast with models of horizontal differentiation. There, costless entry guarantees every entering firm a positive demand.

In a more general framework, Shaked and Sutton (1983) have shown the "finiteness result" for models with vertical product differentiation: high quality firms, through competition in prices, throw low quality firms out of the market. This yields a finite upperbound on the number of firms under free entry if the unit cost of production increases slowly enough with the increase in quality. This is in sharp contrast with models of horizontal differentiation, where the number of firms approaches infinity when the cost of entry becomes negligible.

Recently, models have appeared that allow for location choice both in variety and quality. Neven and Thisse (1990) combine the horizontal and vertical product differentiation model on the Hotelling line. They analyse a duopoly and obtain two kinds of results. Horizontal dominance is said to occur when relative to the horizontal differences of the two products, its vertical characteristics are "closer" to each other. Vertical dominance occurs when the opposite relationship holds. Similar combinations of both horizontal and vertical product differentiation have been carried out by Economides (1989) and Tabuchi (1994).

1.3.2 Monopolistic Competition: Localized and Non-localized Competition.

The main theme of the literature on spatial competition is strategic positioning and price competition. In contrast, research in monopolistic competition takes product differentiation as a given and, therefore, ensures every firm some degree of market power. The central theme is: does the market provide an efficient degree of variety in a free-entry equilibrium? Such an equilibrium is said to exist if existing firms earn non-negative profits and any other entering firm anticipates its profits to be non-positive. Measuring the efficiency loss of a free-entry market outcome is the major theme of this literature.

The literature on monopolistic competition consists of two research strands. The first is due to Chamberlin: *all* firms operating in the industry compete with one another in a more or less symmetric fashion. With many firms, a price change by one firm has only a negligible effect in the demand of every other firm. Chamberlin (1933) states:

> "A price cut, for instance, which increases the sales of him who made it, draws inappreciable amounts from the markets of each of his many competitors, achieving a considerable result for the one who cut, but without making incursions upon the market of any single competitor sufficient to cause him to do anything he would not have done anyway" (Chamberlin, 1933, p. 83, and as quoted in Anderson, De Palma, and Thisse, 1992).

In more modern terminology, the Chamberlinian approach has been called *non-localized* competition. Leading models in this literature are Spence (1976) and Dixit and Stiglitz (1977) who use the representative consumer approach and Perloff and Salop (1985). The latter take a linear random utility model to describe the consumer's demand for differentiated products.

The second strand of literature started off with Kaldor (1935). He criticized the Chamberlinian approach. Kaldor's approach is most easily illustrated with

Salop's (1979) circle model. In this model, a circle represents the product space. A given number of firms is positioned equidistantly on this circle. Their position defines the product's variant. Consumers are distributed along this circle and their position coincides exactly with their most preferred variant. For given prices, a small price change by one firm *only* affects its two neighbouring firms. In other words, the non-neigbouring firms are not affected at all by this small price-cut. Firms, therefore, compete only in a local fashion. This effect of a price change goes to the heart of the Kaldorian approach. In more modern terminology, there is *localized* competition. It is, indeed, fundamentally different from the Chamberlinian approach where every firm competes with every other firm. The consumer's point of view is also illustrative to point at the difference between the two approaches. In the Kaldorian approach, a consumer's position on the circle perfectly reveals his preference ordering for all variants. For example, at equal prices the variant at the shortest arc-length is the most preferred one, followed by the variant at the second shortest arc-length, and so on. In the Chamberlinian approach, however, no such inferences can be made: a consumer's most preferred brand does not yield any information about his second preferred one. Recently, Deneckere and Rothschild (1992) have provided a way to integrate these two approaches into one model.

The above (implicitly) presumed a given number of firms in the industry. Such a presumption is more suited for a short-run analysis. As mentioned above, the common theme of the two approaches, however, is to focus on free-entry for firms; a long-run phenomenon. That is, when no existing firm wants to leave the market and no other firm wants to enter.

Adding this zero-profit condition to the Chamberlinian approach, one arrives at "monopolistic competition". The total number of products is the result of two effects trading off each other (Spence, 1976). The first can be identified as the "non-appropriability of social surplus" effect. Although from a social point of view it may be optimal to introduce a product, the firm's impossibility to first-degree price discriminate may lead him not to enter the market. This negatively affects the diversity of products. The other effect is the "business stealing" effect. Stealing consumers from a rival firm may be without yielding any additional social surplus. This effect tends to generate too many products. In the context of non-localized competition, no clear-cut general result about too few or too many products exists; the specificities of the model determine whether there is excess diversity or not. If, for example, the preference for variety is sufficiently large, a free-entry market economy will generate too few products.

The adding of the zero-profit condition to the Kaldorian approach, however, always yields too many products in the free-entry equilibrium. Norman and Thisse (1994) offer an intuitive interpretation for the main insight offered by the literature on monopolistic competition:

> "In the [Chamberlinian] approach each firm is in competition with all other firms, while in the [Kaldorian] model each firm competes directly only with its immediate neighbours. Hence, for a given number of firms the equilibrium price should be lower and equilibrium should be characterized by less entry in the former case than in the latter." (Norman and Thisse, 1994, *The Economics of Product Differentiation*)

The Chamberlinian 'large group' competition assumes many firms, each with negligible market power (in the sense that a particular firm's actions do not affect other firms' payoffs) but offer a differentiated commodity so that their demand is downward sloping or has finite elasticity. This absence of strategic behavior has been motivated to simplify the analysis while focusing on the variety of products offered. Recently, Anderson et al. (1995) have offered a model of Chamberlinian competition that allows for strategic behavior between firms. Their analysis has shown that the free-entry equilibrium results in too many firms *vis-à-vis* the socially optimal product diversity.

1.3.3 Summary of the Essays with Product Differentiation

Essays one to three make use of the two basic models of spatial competition. This approach offers a framework that *can explain optimal business-strategies*; that is, optimal product positioning and price setting behavior. The first essay **Phonebanking** studies under what conditions banks offer phonebanking (first stage). The banks compete for the deposits of consumers located along a circle. The location of the banks is exogenously fixed. At a phonebank, depositors can exercise some financial transactions by phone. Using the phone option has the same cost for every depositor. In this first stage, banks decide about the quality of their product. This essay, therefore, combines both horizontal and vertical differentiation. In the second stage, banks are competitors in the market for deposits. Offering the phone option creates two opposing effects. The first is a demand effect as depositors strictly prefer to manage some of their financial transactions by phone. The second (strategic) effect is that competition is increased as transaction costs are lowered. No bank offers the phone option if the strategic effect dominates. Specialization can occur in that one bank offers the phone option while the other does not. It requires a relatively large demand effect and a moderate strategic effect. Finally, both banks offer the phone option when the demand effect dominates the strategic effect. It leads to tougher price competition than a situation without phonebanking. This essay is based on: Bouckaert, J. and H. Degryse (1995), **Phonebanking**, *European Economic Review*, 39, 229-244.

The second essay **Monopolistic Competition with a Mail Order Business** studies a market in which firms can choose to sell either by a retail store or by a mail order business. For the consumer, purchases made at retail stores entail transportation costs that increase with distance. In contrast, a consumer served by a mail order business pays a fixed cost, irrespective of his or her location. This essay concentrates on two issues. First, in a strategic context it studies how firms will market their product (spatial competition). Second, it also looks at the free-entry equilibrium number of firms. In the free-entry equilibrium, at most one mail order business emerges. Moreover, the mail order business competes in a non-localized fashion with all stores. The retail stores, however, compete in a localized way with the mail order business. This essay, therefore, contributes to combining issues of the non-localized and localized tradition. Compared to the circle-model without mail order business, fewer firms are active in the free-entry mail order business equilibrium. In consequence, competition becomes more fierce. In contrast with the free-entry case, the social planner never opens both stores and a mail order business at the same time.

The third essay studies **Price Competition between an Expert and a Non-expert**. As in essay one, it deals with horizontal and vertical product differentiation. The expert is located at the right extreme of the interval and the non-expert at the left extreme. Consumers are uniformly distributed along the unit interval. They require a successful repair and seek to minimize their expected expenditure. The expert always repairs successfully. The non-expert's repair technology, however, is imperfect: he successfully repairs only with some probability. In addition, if the repair fails, a next visit at the non-expert's store always results in failure. A consumer who visits the non-expert anticipates he will re-enter the market as a "failure" if the repair was unsuccessful. From the characteristics of the non-expert's repair technology, the only choice left for this "failure" is to visit the expert's store. Essentially, the expert's choice is either to serve only failures or not. If the expert serves only failures, demand becomes inelastic and it is optimal to charge the monopoly price. For sufficiently high probabilities of successful repair at the non-expert's store, it is not optimal for the expert to serve only failures as this market becomes very small. The expert, therefore, adopts an "agressive-pricing" strategy. By consequence, some consumers directly visit the expert. This equilibrium is in pure strategies. Otherwise, the expert uses a mixed strategy. In this "mixed-pricing" equilibrium the expert charges with some probability a low price. With the remaining probability, he charges the monopoly price. In that event, all consumers first visit the non-expert. The welfare analysis shows that when the expert incurs a cost-disadvantage, the market outcome in pure strategies results in too many consumers directly visiting the expert. The opposite occurs without cost differences.

1.4 Price Commitment and Bargaining in Markets.

The Bertrand model (see Section **1.2**) assumes that sellers can commit themselves to a price. Therefore, buyers have no power in determining the price. To put it in another way, buyers have no bargaining power since prices are set on a take-it-or-leave-it basis.

The Bertrand assumption of *price commitment*, however, has serious drawbacks. One of these drawbacks is that the concept of Bertrand competition implies counterintuitive results as Diamond (1971) has shown. He introduced a model where, in contrast with Bertrand's model, buyers are imperfectly informed about the seller's price. That is, they have to incur a strictly positive search cost to get informed about the seller's price. In that model, it turns out that even when search costs are negligibly small (but positive) and the number of sellers becomes very large the equilibrium price equals the monopoly price.[4] This has come to be known as the *Diamond-* or *monopoly-paradox*. As in the Bertrand-paradox, it seems too strong to be taken as a "reasonable" way of modelling price competition between firms. Several ways out of this monopoly-paradox have been proposed. Butters (1977) and Salop and Stiglitz (1977) have introduced consumers that are informed about the price whereas others

[4]This version of Diamond's model assumes that consumers can costlessly visit the first seller. This assumption is made to avoid that the consumers would not enter the market at all.

remained uninformed. In their settings, informed consumers exert a positive externality on the uninformed while the uninformed exert a negative externality on the informed. The interesting feature of these models is that price dispersion can be explained in equilibrium. In addition, when the information uncertainty about the prices vanishes, the perfectly competitive outcome emerges as the outcome.

In contrast with price commitment, the concept of *bargaining* or *negotiated pricing* gives the buyer some power in determining the price. This bargaining approach undermines the seller's possibility of committing to a price. Thus, the terms of trade are determined by negotiation. This framework weakens the seller's market power and, in contrast with price commitment, allows for a more symmetric treatment of both sides of the market.[5] Bester (1988) has shown that the bargaining approach may serve as a tool of analysis to solve the Diamond-paradox. In his model search costs imply imperfect information about the quality of the good. When search costs become negligible small, the buyer's uncertainty about the quality disappears and sellers' profits approach zero. In this way, the competitive equilibrium is restored when market frictions disappear.

Another drawback of price competition where sellers commit to a price is that existence of an equilibrium is not always assured. As mentioned in Section **1.3**, in case of linear transportation costs Hotelling's model of product differentiation may fail to have a price equilibrium as shown by d'Aspremont et al. (1979). When the two firms are located close enough to each other, both have an incentive to slightly undercut the other. In Hotelling's model, the undercutting firm then attracts the whole market. This practice can be done as long as profits are positive. In a horizontal differentiation model, however, every firm can guarantee itself some market power. Therefore, a price equilibrium where one firm obtains zero profits cannot exist. Bester (1989b) solves Hotelling's location-price game in a negotiated pricing framework. In his bargaining framework,

[5]See Bester (1989a) for a compact survey on non-cooperative bargaining and imperfect competition.

consumers can use their outside option as a threat to visit another seller. His findings are that in the limit, when the degree of substitutability between the stores increases, the competitive outcome is established. This result holds if buyers can increase their speed of travelling between two stores to infinity or when the number of sellers increases such that the equilibrium distance between two stores becomes negligibly small.

In sharp contrast with the Walrasian framework, the general idea behind bargaining in markets is to analyze markets where trade is decentralized. The trading partners are assumed to be in a partial bilateral monopoly situation: switching costs from one to the other trading partner rule out that multilateral trade can take place. In the event the trading partners cannot reach an agreement about the terms of trade, both can switch to another trading partner. The level of the switching costs, therefore, will partly determine each trading partner's bargaining position. This approach allows to explicitly analyze the effects of market frictions on the equilibrium outcome of the market. In addition, it may determine whether the equilibrium converges to the perfectly competitive one when the market frictions vanish. That is, a bargaining model may serve as a foundation for the Walrasian equilibrium when the market frictions go to zero.

Two approaches have been used to model the outcome of the bargaining. The first is the *Cooperative Bargaining Approach*. It consists of a set of feasible payoffs and a 'status-quo' point. The most well-known solution concept is the Nash-bargaining solution. This solution concept satisfies four axioms: Pareto-efficiency, invariance to affine transformations of the utility functions, symmetry, and independence of irrelevant alternatives. Nash (1950) has shown that these four axioms result in a unique outcome. The second approach is the *Non-Cooperative Bargaining Approach*. In sharp contrast with the previous (institutional-free) approach, this non-cooperative approach offers a precise description of the bargaining procedure. In other words, the institutional setting is defined explicitly. It models the bargaining solution as an extensive game, and uses a game theoretic solution concept (e.g. the Subgame Perfect equilibrium) to determine the outcome of the bargaining. As an example of such an extensive game, take the alternating offers bargaining game (Rubinstein, 1982): two impatient players, with diametrically opposed interests, must share a monetary unit by making sequential, alternating offers. If the opponent accepts the offer, the game ends. If he rejects the offer, he makes a counteroffer in the next stage of the game, and so on. If no agreement can be reached, both receive zero. This is a game of perfect information, and has a unique Subgame Perfect Nash equilibrium where agreement is reached immediately. The non-cooperative bargaining approach has been used e.g. to explain markets with non-Walrasian outcomes (see Shaked and Sutton (1984) who explain involuntary unemployment), and to markets where outcomes with price commitment do not exist (see above). The cooperative approach and the non-cooperative approach, however, need not be inconsistent with each other. Recently, it has been shown by Binmore, Rubinstein, and Wolinsky (1986) that the Nash bargaining solution coincides with the non-cooperative outcome of an alternating offers bargaining game in which the probability of an exogenous breakdown vanishes.

1.4.1 Summary of Essay on Bargaining in Markets

Essay four of this dissertation studies **Bargaining in Markets with Simultaneous and Sequential Suppliers**. It uses the cooperative bargaining approach. This essay compares the Nash bargaining outcomes in two market organizations where suppliers, e.g. taxi-drivers, wait at stand for customers to arrive. At most one customer arrives per period of time. In the first market organization (the random-market) suppliers simultaneously offer their good for sale. Customers, upon arrival, may randomly select a supplier. If agreement is reached, both partners symmetrically share the surplus. If there is disagreement, customers may, in the next period, again randomly select a supplier, and so on. In the second market organization (the FIFO-market) suppliers queue and sequentially offer their good for sale. Upon arrival, customers have to take the first supplier in the queue and, upon disagreement, stick to the same supplier. Customers are involved in a partial bilateral monopoly in the random-market. The FIFO-market, however, is characterized by a bilateral monopoly and, therefore, results in a higher outcome. When customers cannot choose regime, the market equilibrium always has the property that there are suppliers in both regimes. In the limit, when the number of suppliers becomes very large, the ratio of suppliers in the random-market to the FIFO-market tends to infinity.

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Chapter 2

Phonebanking

2.1 Introduction

Technological innovation over the past decade redesigned the art of competition in banking. Recently, the innovation 'phonebanking' appeared as a "banking facility which can be accessed remotely by a customer via his or her telephone" (Essinger, 1992, p.152). Phonebanking facilities include, for example, statement and check book ordering, third party payments and up to date account information.[1] The number of banks offering this kind of access has increased substantially during the recent past. In Belgium, France, Germany, the United Kingdom and Sweden, virtually all major banks offer phonebanking. The percentage of these banks' depositors using this innovation ranges from 2 to 15 for Belgium, 3 to 50 for France and 3 to 100 for the United Kingdom.[2]

In this chapter, depositors value a phonebank since it facilitates access to their account. Using the phone option reduces their *transaction* costs to manage their account. For example, it may lower their travelling costs. Therefore, depositors are willing to accept lower deposit rates in order to become clients at a phonebank.[3]

[1] A formally equivalent idea has already been in existence for some time: depositors use envelopes to order their financial transactions by mail.

[2] For an overview of the importance of phonebanking, see BEUC (1992) and BIS (1993).

[3] Heffernan (1992) computes the interest equivalence for a list of nonprice characteristics of bank products but excludes the phone option.

The chapter considers a spatial duopoly. It analyzes whether banks will offer phonebanking to their clients or not and what the effects upon their market shares, deposit rates and profits will be. A deposit market with related financial services is modelled as a two-stage game. In the first stage, banks decide whether to introduce the phone option or not. In the second stage, banks compete in deposit rates. We apply a model related to the Salop (1979) circle model. At a phonebank, depositors can exercise some financial transactions by phone. Using the phone option has the same cost for every depositor. Graphically, the phone option can be modelled as the center of a circle: the distance from the center is the same for every point on the circle. [4] Each depositor, being a client at a phonebank, has the opportunity to exercise some of his or her transactions at a fixed cost.[5]

Offering the phone option has two opposite effects. First, it makes the bank offering that option more attractive to depositors (demand effect). Second, it encourages competition among banks as it implies lower transaction costs (strategic effect). Banks do not offer the phone option (*no phonebanking*) if the strategic effect dominates. Only one bank offering the phone option (*specialization*) requires a relatively large demand effect and a moderate strategic effect. Two phonebanks (*universal phonebanking*) appear if the demand effect overwhelms the strategic effect. Since universal phonebanking implies lower transaction costs, it leads to tougher competition than no phonebanking.

Silber (1983) offers an overview of the process of financial innovations. His main hypothesis is that "new financial practices are innovated to lessen the financial constraints imposed on firms" (p.89). Both external and internal constraints are at the origin of their innovative activity. This chapter studies the competitive effects of phonebanking as an option for clients to execute their financial transactions when banks are competitors in the market for deposits.

[4] Henriet and Rochet (1991) consider a similar framework to analyze competition in the distribution of insurance. Insurance intermediaries are located along the circle and a direct writer is located at the center of the circle. The cost to approach the direct writer is uniformly high for all buyers of insurance (represented by the length of the radius).

[5] Some banks introduced a phone number per phone area. Therefore, the cost for a depositor to use the phone option is the same for all depositors irrespective of their location.

In this way, innovation in the financial services industry is the result of *strategic* positioning.

Matutes and Padilla (1994) address the effect of ATM compatibility on banking competition in the deposit market. They show that either full incompatibility or partial compatibility occurs. Full compatibility never constitutes a Perfect Coalition-Proof Nash equilibrium in pure strategies. A coalition of two compatible banks vetoes full compatibility since the competitive effects dominate the increase in network effects. Phonebanking however, contains *no* network effects, since the cost of exercising a transaction by phone is independent of the number of banks offering the phone option. Therefore, we do not need more than two banks for the analysis.

The rest of the chapter is organized as follows. Section **2.2** presents the model. Section **2.3** offers the solution of the game and interprets the results. Section **2.4** concludes.

2.2 A Model of Spatial Phonebanking Competition on the Circle.

Two banks A and B, each consisting of a single branch, are located on a circle with unit circumference.[6] By convention, bank A is located at 0 and bank B has its location at $1/2$.[7] Banks compete for the deposits of individuals located along the circle. Competition is modelled as a two-stage game. At stage one, banks simultaneously decide whether to offer their depositors the phone option or not. The introduction of this technology is costless for both banks. We assume that the processing cost for the bank of a transaction executed by phone or at a branch is the same. This cost is normalized at zero. At stage two, given the decision by the two banks about stage one, they simultaneously set deposit rates r_i, with $i = A, B$. Deposits are invested and generate a fixed return $R \geq r_i$.[8]

[6] One could think of a town or a district where a bank opens only one branch.

[7] This specific location setting will generate analogous conclusions as in a traditional Hotelling model where banks A and B are located at 0 and 1, respectively.

[8] The chapter takes the existence of the banking firm as a given and focuses only on its liability side.

The profit of bank i is $\pi_i = (R - r_i)y$ with y the amount of deposits attracted.

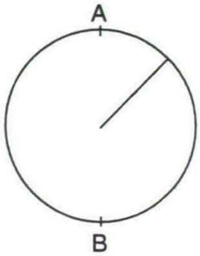

Figure 1: The circle model.

Depositors are uniformly distributed with density one along the circle and competition is such that all depositors open a deposit account. Each depositor invests on average one normalized unit of money at only one of the two banks.

Depositors exercise a fixed number of four different financial transactions (see Table 1).[9]

	location-specific	*non-location-specific*
branch-specific	H	M
non-branch-specific	h	m

Table 1: Overview of financial transactions.

The first two kinds arise when the depositor is at his home location. We call these *location-specific*. Each depositor has a well-defined location (i.e. his home location) and from this point he exercises H *branch-specific* and h *non-branch-specific* transactions. Examples of *branch-specific* transactions are deposits or withdrawals of cash which clearly need a visit to the branch. A depositor

[9] We assume that the number of each type of transaction is already the result of an optimization procedure. Their fixed character, however, simplifies calculation.

located at z visits its branch always via the shortest arc length implying a transportation cost $k + tz$, with $k > 0$ as the constant term and $t > 0$ the per-unit distance parameter. An economic interpretation for k is the average cost in waiting time that every depositor incurs before getting served at the bank desk. Examples of *non-branch-specific* transactions include provisions, transfers, and payments which do not need a visit to the branch. If a bank offers its depositors the phone option, two possibilities exist for the exercise of *non-branch-specific* transactions: depositors either phone their bank at a fixed cost $\tau > 0$, or visit their bank and face the above transportation cost k plus t per-unit distance. We will assume throughout the analysis that $k \geq \tau$. This implies that all depositors prefer the phone option for the *non-branch-specific* transactions.[10]

The other two transactions are *non-location-specific* and occur during travelling time. The notion of *non-location-specific* means that if a depositor travels to some point on the circle, he can execute financial transactions from that point. We assume that the depositors arrive at some place on the circle, according to the uniform distribution.[11] Again, there are *branch-specific* and *non-branch-specific* transactions. Then, the expected cost for M *branch-specific* transactions equals $M(k + t/4)$, since the expected distance to the depositor's bank is $1/4$. The expected cost for m *non-branch-specific* transactions in case no phone option is available, is obtained in a similar fashion. If the phone option is available, all depositors prefer it, since $k \geq \tau$.

If x is bank A's market share, the depositor who is indifferent between two non-phonebanks A and B is located at $x/2$ such that

$$r_A - (H + h)(k + t\frac{x}{2}) - (M + m)(k + \frac{t}{4}) =$$

$$r_B - (H + h)(k + t\frac{(1 - x)}{2}) - (M + m)(k + \frac{t}{4}). \qquad (1)$$

In eq. (1), the *non-location-specific* transactions cancel out. In other words, banks are perfect substitutes for these transactions.

[10]In other words, offering the phone option is a quality improvement. In case $k < \tau$, best-response functions become kinked and discontinuous such that the existence of a Subgame Perfect Nash Equilibrium (SPNE) in pure strategies is not ensured.

[11]Matutes and Padilla (1994) introduce similar transactions; in their model, depositors need cash unexpectedly when "travelling" around the city.

The depositor who is indifferent between phonebank A and non-phonebank B is located at $x/2$ such that

$$r_A - H(k + t\frac{x}{2}) - h\tau - M(k + \frac{t}{4}) - m\tau =$$

$$r_B - (H + h)(k + t\frac{(1-x)}{2}) - (M + m)(k + \frac{t}{4}). \tag{2}$$

In eq. (2) m-transactions do not longer cancel out. In addition, the *non-branch-specific* transactions imply a lower cost at the phonebank. These differences in transaction costs have an impact on the marginal depositor.

The depositor who is indifferent between two phonebanks A and B is located at $x/2$ such that

$$r_A - H(k + t\frac{x}{2}) - h\tau - M(k + \frac{t}{4}) - m\tau =$$

$$r_B - H(k + t\frac{(1-x)}{2}) - h\tau - M(k + \frac{t}{4}) - m\tau. \tag{3}$$

The terms concerning h-, m- and M-transactions disappear. Their fixed cost character explains this result. The market shares x and $1 - x$ between two phonebanks are determined by the deposit rates and the H-transactions.

Some additional notation is introduced before moving to the following section. Denote by P_i phonebank i and by N_i non-phonebank i.

2.3 Solution of the Game.

We solve the game for its Subgame Perfect Nash Equilibria (SPNE) in pure strategies by backward induction. Subsection **2.3.1** focuses on the equilibria for the game in stage two, given the decisions by the two banks taken in the first stage. The SPNE for the two-stage game are presented in subsection **2.3.2**.

2.3.1 Second Stage Competition: The Choice of Interest Rates.

There are three subgames[12] to be considered: two non-phonebanks (N_A, N_B) (section **2.3.1.1**), one phonebank only (P_A, N_B) (section **2.3.1.2**) and two

[12] The same results apply for the cases where bank B is the first element in the tuple.

phonebanks (P_A, P_B) (section **2.3.1.3**). In order to derive a Nash equilibrium in deposit rates for each subgame, we compute the best response functions for both banks, taking into account that the behavior of the indifferent depositor determines their market share. Section **2.3.1.4** interprets the results within and across subgames.

2.3.1.1 Subgame $(\mathbf{N_A}, \mathbf{N_B})$.

This subgame is comparable to a well-known model of product differentiation on the circle with linear transportation costs, since every depositor has to execute all transactions at the branch of his bank. From (1), bank A's market share is

$$x = \frac{1}{t(H+h)}(r_A - r_B + \frac{t(H+h)}{2}). \tag{4}$$

Substituting (4) into bank A's profit function, we obtain its best response function :

$$r_A = \frac{1}{2}(r_B - \frac{t(H+h)}{2} + R). \tag{5}$$

In a similar way, one finds the best response function for bank B. In equilibrium, each bank captures half of the market, charges the same deposit rate $r_A^*(N_A, N_B) = r_B^*(N_A, N_B) = R - t(H+h)/2$ and obtains as profit

$$\pi_A^*(N_A, N_B) = \pi_B^*(N_A, N_B) = \frac{t(H+h)}{4}. \tag{6}$$

Equation (6) contains only *location-specific* transactions. The m- and M-transactions disappear because of a Bertrand result : banks are not differentiated with respect to these *non-location-specific* transactions.

Comparative statics for the (N_A, N_B) case are shown in Table 2. An increase in t enhances both banks' monopoly power, generating lower deposit rates and higher profits. Both types of *location-specific* transactions reduce the equilibrium deposit rate and increase profits. Changes in exogenous variables do not affect the equilibrium market share. The M-transactions and the difference $k-\tau$ do not influence the equilibrium deposit rate, market share and profits.

	t	H	h	M	m	$k-\tau$
r_i^*	$-$	$-$	$-$	0	0	0
x_i^*	0	0	0	0	0	0
π_i^*	+	+	+	0	0	0

Table 2: Comparative statics for the (N_A, N_B) case.

2.3.1.2 Subgame $(\mathbf{P_A}, \mathbf{N_B})$.

In the second subgame, only one bank offers the phone option. From eq. (2), bank A's market share is

$$x = \frac{2}{t(2H+h)}(r_A - r_B + h(k-\tau) + m(k-\tau+\frac{t}{4}) + \frac{t(H+h)}{2}). \qquad (7)$$

Substituting eq. (7) into bank A's profit function, its best-response function equals

$$r_A = \frac{1}{2}(r_B - \frac{t(H+h)}{2} - h(k-\tau) - m(k-\tau+\frac{t}{4}) + R). \qquad (8)$$

Substituting eq. (7) into bank B's profit function, its best-response function becomes:

$$r_B = \frac{1}{2}(r_A - \frac{tH}{2} + h(k-\tau) + m(k-\tau+\frac{t}{4}) + R). \qquad (9)$$

From eqs. (8) and (9) the equilibrium deposit rates for this subgame are :

$$r_A^*(P_A, N_B) = R - \frac{t(H+h)}{2} - \frac{h}{3}(k-\tau) + \frac{th}{6} - \frac{m}{3}(k-\tau+\frac{t}{4}) \qquad (10)$$

and

$$r_B^*(P_A, N_B) = R - \frac{t(H+h)}{2} + \frac{h}{3}(k-\tau) + \frac{th}{3} + \frac{m}{3}(k-\tau+\frac{t}{4}). \qquad (11)$$

The corresponding equilibrium market shares are :

$$x_A^*(P_A, N_B) = \frac{2}{t(2H+h)}(\frac{t(3H+2h)}{6} + \frac{h}{3}(k-\tau) + \frac{m}{3}(k-\tau+\frac{t}{4})) \quad (12)$$

and

$$x_B^*(P_A, N_B) = \frac{2}{t(2H+h)}(\frac{t(3H+h)}{6} - \frac{h}{3}(k-\tau) - \frac{m}{3}(k-\tau+\frac{t}{4})). \quad (13)$$

It follows that the equilibrium profits are :

$$\pi_A^*(P_A, N_B) = \frac{2}{t(2H+h)}(\frac{t(3H+2h)}{6} + \frac{h}{3}(k-\tau) + \frac{m}{3}(k-\tau+\frac{t}{4}))^2 \quad (14)$$

and

$$\pi_B^*(P_A, N_B) = \frac{2}{t(2H+h)}(\frac{t(3H+h)}{6} - \frac{h}{3}(k-\tau) - \frac{m}{3}(k-\tau+\frac{t}{4}))^2. \quad (15)$$

In this subgame, banks are clearly differentiated with respect to the m-, h- and H-transactions. As a consequence, these transactions enter into the profit functions.

	t	H	h	M	m	$k-\tau$
r_A^*	$-$	$-$	$-$	0	$-$	$-$
r_B^*	$-$	$-$	$-$	0	$+$	$+$
x_A^*	$-$	$-$	?	0	$+$	$+$
x_B^*	$+$	$+$	?	0	$-$	$-$
π_A^*	$+$	$+$	?	0	$+$	$+$
π_B^*	$+$	$+$	?	0	$-$	$-$

Table 3: Comparative statics for the (P_A, N_B) case.

Comparative statics for the (P_A, N_B) case are summarized in Table 3. Higher transportation costs reduce both banks' deposit rates. However, they affect the (non-) phonebank's market share in a (positive) negative way. The overall effect on profits is positive for both banks. *Location-specific* transactions increase the intermediation rate for both banks. The H-transactions reduce the phonebank's market share to the advantage of the non-phonebank and decrease the gains from differentiation. The effect of h-transactions on the deposit rate is negative, while the effect on market share and profits is ambiguous. The m-transactions and the difference in fixed costs $k-\tau$ reduce (increase) the (non-)phonebank's deposit rate and increase (reduce) market share. They both unambiguously enhance (reduce) the profits of the (non-) phonebank.

2.3.1.3 Subgame $(\mathbf{P_A}, \mathbf{P_B})$.

From eq. (3), bank A's market share is

$$x = \frac{1}{tH}(r_A - r_B + \frac{tH}{2}). \tag{16}$$

Substituting eq. (16) into bank A's profit function, we can derive its best response function:

$$r_A = \frac{1}{2}(r_B - \frac{tH}{2} + R). \tag{17}$$

Bank B's best-response function is similarly derived. In equilibrium, each bank captures half of the market and offers as deposit rate

$$r_A^*(P_A, P_B) = r_B^*(P_A, P_B) = R - \frac{tH}{2}. \tag{18}$$

The equilibrium profits are

$$\pi_A^*(P_A, P_B) = \pi_B^*(P_A, P_B) = \frac{tH}{4}. \tag{19}$$

Equation (19) shows that the h-transactions do not enter the profit function for the same reason as the m- and M-transactions in eq. (6). Banks are not differentiated with respect to the h-transactions, and price competition cannot be relaxed. Consequently, a Bertrand result appears.

Comparative statics are summarized in Table 4 and are similar to the (N_A, N_B) case except for the h-transactions.

	t	H	h	M	m	$k-\tau$
r_i^*	$-$	$-$	0	0	0	0
x_i^*	0	0	0	0	0	0
π_i^*	$+$	$+$	0	0	0	0

Table 4: Comparative statics for the (P_A, P_B) case.

2.3.1.4. Interpretation.

Before moving to the first stage, some comparisons can be made about the deposit rates and market shares within and across the different subgames. First, $r_A^*(P_A, N_B)$ can either be larger or smaller than $r_A^*(N_A, N_B)$. This ambiguity stems from two reasons. The first is that in the (P_A, N_B) case more differentiation is introduced *vis-à-vis* the (N_A, N_B) case: all depositors strictly prefer the phone option for their m- and h-transactions being offered at bank A only. This results in a reduction of A's deposit rate as shown by the third and fifth term in eq. (10). The same reasoning explains the opposite observation in eq. (11) for bank B's deposit rate. The other reason is that less differentiation results in banks competing more strenuously for the same depositors: neighboring depositors become less captive, resulting in a reduction of their monopoly power. The fourth component in eqs. (10) and (11) illustrates this effect. Adding up both effects generates the above ambiguity for bank A. For bank B, however, no ambiguity results, since $r_B^*(P_A, N_B) > r_B^*(N_A, N_B)$. The non-phonebank increases its deposit rate on deposits in order not to be driven out of the market.

Second, $r_B^*(P_A, N_B) > r_A^*(P_A, N_B)$. Bank A is differentiated from B and can use its monopoly power to charge a lower deposit rate.

Third, $r_A^*(P_A, N_B) < r_A^*(P_A, P_B)$. When both banks introduce the phone option, they are not differentiated with respect to their m- and h-transactions: a Bertrand result holds for these transactions. If bank B does not offer the phone option, more differentiation results. Depositors prefer bank A in order to execute their m- and h-transactions. Therefore, they become more captive *vis-à-vis* the situation where both banks offer the phone option. This results in a lower deposit rate. The same reasoning explains why $r_B^*(P_A, N_B)$ can either be larger or smaller than $r_B^*(P_A, P_B)$.

Fourth, $r_i^*(N_A, N_B) < r_i^*(P_A, P_B)$, with $i = A, B$. Both banks are differentiated with respect to their h-transactions when both banks do not offer the phone option. This is not the case if both banks offer the phone option. The introduction of the phone option unambiguously steps up competition between banks, yielding a higher deposit rate.

Fifth, $x_A^*(P_A, N_B) > x_B^*(P_A, N_B)$. The phonebank clearly attracts a higher market share *vis-à-vis* the subgames (N_A, N_B) and (P_A, P_B). Two effects can be distinguished in case bank A deviates from the (N_A, N_B) towards the (P_A, N_B) case.[13] One is the *demand effect* (the direct effect) through a change in market share given B's equilibrium deposit rate of the (N_A, N_B) case. This change equals

$$x_A(P_A, N_B)|_{(N_A,N_B)} - x_A^*(N_A, N_B) = \frac{2}{t(2H+h)}\left(\frac{th}{4} + h(k-\tau) + \frac{m}{2}\left(k-\tau+\frac{t}{4}\right)\right) > 0 \tag{20}$$

and is positive since depositors strictly prefer to execute their m- and h-transactions by phone. The direct effect on profits is positive, since bank A's deposit rate decreases. The other is the *strategic effect* (the indirect effect) and captures the impact on A's (the phonebank's) profits through the change in B's (the non-phonebank's) deposit rate. The effect on market share is negative and equals

$$x_A^*(P_A, N_B) - x_A(P_A, N_B)|_{(N_A,N_B)} = \frac{2}{t(2H+h)}\left(-\frac{th}{6} - \frac{h}{6}(k-\tau) - \frac{m}{6}\left(k-\tau+\frac{t}{4}\right)\right) < 0. \tag{21}$$

[13]See Tirole (1988, p. 281) for more details on these two effects.

The change in deposit rate is positive, resulting in a negative strategic effect on profits. Adding up eqs. (20) and (21), the total change in terms of market share becomes positive: a phonebank competing with a non-phonebank attracts a higher market share. The *total* effect on profits, however, is ambiguous.

Sixth, a simple welfare analysis shows that depositors are best off if both banks offer the phone option. The introduction of the phone option by only one bank also increases the welfare of the depositors. Both increases in welfare result from a combination of the competitive effects between banks and the decrease in transportation costs. The depositors strictly prefer (P_A, P_B) to (P_A, N_B) and (P_A, N_B) to (N_A, N_B).

Finally, using the terminology of Fudenberg and Tirole (1984), banks act as *puppy dogs* in their decision to offer the phone option. According to the above analysis, that decision negatively (positively) influences the opponent's market share (deposit rate), irrespective of his first-stage decision. Due to the negative effect on the opponent's profit, offering the phone is a tough strategy. Since price competition yields strategic complements, the *puppy dog* strategy follows. As a result, banks show a tendency towards *underinvestment* in the phone technology.

2.3.2 First Stage Competition: Phone Option Decision.

In the first stage of the game, the two banks simultaneously choose whether to introduce the phone option or not. They do so knowing that in the second stage they will compete in deposit rates as described in subsection **3.1**.

From eqs. (1), (2) and (3), M-transactions do not affect the marginal depositor. Therefore, M equals zero without loss of generality. In what follows, we normalize $h + H + m = 1$. Then, m measures the percentage of *non-location-specific* transactions. For the sake of simplicity, assume $H = \alpha h$, so that $h = (1 - m)/(1 + \alpha)$ and $m \in [0, 1]$.

The following proposition characterizes all possible SPNE in pure strategies for the overall game.

Proposition: *Let* $H = \alpha h > 0$, $h + H + m = 1$,

$$\underline{m}(t) \equiv 1 - \frac{(4(k-\tau)+t)(\alpha+1)}{3t\sqrt{2(\alpha+1)(2\alpha+1)} + \alpha(4(k-\tau)-5t) - 3t}$$

and

$$\overline{m}(t) \equiv 1 - \frac{(4(k-\tau)+t)(\alpha+1)}{-3t\sqrt{2\alpha(2\alpha+1)} + \alpha(4(k-\tau)+7t) + 3t}.$$

a) If $m \in [0, \underline{m}(t)]$, *then no bank introduces the phone option (region* I*).*
b) If $m \in [\underline{m}(t), \overline{m}(t)]$, *then only one bank introduces the phone option (region* II*).*
c) If $m \in [\overline{m}(t), 1)$, *then both banks introduce the phone option (region* III*).*

Proof : Straightforward calculations show that $\pi_i^*(P_i, N_j) \leq \pi_i^*(N_i, N_j)$ if and only if $m \leq \underline{m}(t)$ and $\pi_j^*(P_i, P_j) \leq \pi_j^*(P_i, N_j)$ if and only if $m \leq \overline{m}(t)$, $i \neq j$ and for all $i, j \in \{A, B\}$. Notice that $\underline{m}(t) \leq \overline{m}(t)$.
a) For $m \leq \underline{m}(t)$, we have that $\pi_i^*(P_i, N_j) \leq \pi_i^*(N_i, N_j)$ and $\pi_j^*(P_i, P_j) \leq \pi_j^*(P_i, N_j)$ hold, resulting in (N_A, N_B) as the unique SPNE.
b) For $\underline{m}(t) \leq m \leq \overline{m}(t)$, we have that $\pi_i^*(P_i, N_j) \geq \pi_i^*(N_i, N_j)$ and $\pi_j^*(P_i, P_j) \leq \pi_j^*(P_i, N_j)$ hold. This results in (P_A, N_B) and (N_A, P_B) as the two SPNE.
c) For $\overline{m}(t) \leq m$, we have that $\pi_j^*(P_i, P_j) \geq \pi_j^*(P_i, N_j)$ and $\pi_i^*(P_i, N_j) \geq \pi_i^*(N_i, N_j)$ hold, resulting in (P_A, P_B) as the unique SPNE. □

Figure 2 illustrates the proposition for given values of α, τ and k. We depict t on the horizontal and m on the vertical axis. The functions $\underline{m}(t)$ and $\overline{m}(t)$ represent the borderlines between regions I and II, II and III, respectively. From the normalization, the size of the regions is a measure for their relative importance.

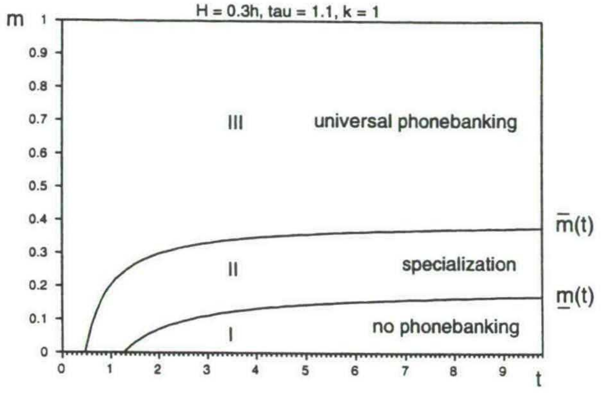

Figure 2: The phone option decision.

The equilibrium outcome depends on the relative strength of the demand and strategic effect. Region *I* describes the parameter constellations for an equilibrium with *no phonebanking*. Introducing the phone option in that region implies a strategic effect outweighing the demand effect. Thus, although offering the phone option yields a higher market share, the percentage of m-transactions is too low to compensate for the encouraged competition. The higher their percentage, however, the more a depositor values a phonebank.

Region *II* satisfies the parameter constellations for *specialization*: only one bank offers the phone option. Specialization occurs whenever transportation costs are sufficiently high and m has intermediate values. Here, offering the phone option implies a demand effect dominating the strategic effect. Only in this region, the depositors' value for the phone option affects the marginal depositor. The phonebank appropriates part of its depositors' value for the phone option. Therefore, it enjoys a lower deposit rate and a larger market share compared to the non-phonebank. The latter does not offer the phone option, as it induces two effects. First, the percentage of m-transactions would not affect the marginal depositor's choice of bank anymore. Second, it would result in a lower degree of horizontal differentiation, enhancing competition. Adding up, the strategic effect overwhelms the demand effect. It is clear that a coordination problem arises with respect to who will become the phonebank. A sequential game where nature decides who moves first, could solve this problem.

Region III contains the parameter constellations where *universal phonebanking* takes place. Each bank individually decides to offer the phone option: the demand effect always dominates the strategic effect. Remark that (N_A, N_B) as well as (P_A, P_B) are standard models of product differentiation, the latter having lower costs of transportation. Therefore, in region III a Prisoner's dilemma situation occurs. Although not introducing the phone option would be more profitable for both banks, each bank individually decides to offer the phone option.

The borderline $\underline{m}(t)$ is upward-sloping and concave. The slope can be explained from eqs. (6) and (14), where $\partial\pi_A^*(N_A, N_B)/\partial t > \partial\pi_A^*(P_A, N_B)/\partial t$ for any (m,t) satisfying $m = \underline{m}(t)$. For a given m, the strategic effect increases with t, whereas the demand effect is decreasing. An increase in the m-transactions countervails these two effects. That is, along this borderline, a bank needs more m-transactions when offering the phone as t increases. Concavity results from $\partial^2\pi_A^*(P_A, N_B)/\partial m^2 > 0$. In a similar way, one can explain the upward-sloping concave borderline $\overline{m}(t)$ separating regions II and III.

The demand effect becomes more important when the cost difference $k - \tau$ increases. In other words, the size of region III (universal phonebanking) increases. The opposite holds for region I (no phonebanking). The size of regions I, II and III depends upon the *underinvestment* effect. The *puppy dog* strategy enlarges the set of parameters satisfying regions I and II.

Two special cases remain. First, if $m = 1$, (P_A, N_B), (N_A, P_B) and (P_A, P_B) are SPNE. The second-stage equilibrium in both the (P_A, P_B) and (N_A, N_B) case is setting $r_i = R$. In cases (P_A, N_B) or (N_A, P_B), the phonebank's optimal deposit rate drives its non-phone competitor out of the market. (N_A, N_B) cannot be an SPNE, since one bank always makes strictly positive profits by offering the phone option. Then, the non-phonebank cannot strictly increase its profits with also offering the phone option. The same reasoning applies to the (P_A, P_B) equilibrium. Each SPNE enables all depositors to make use of the phone option. However, all gains from the phone technology are captured by depositors when both banks offer the phone option. Second, if $\alpha = 0$, the results for regions I and II of figure 2 remain intact. Region III, however, shows three SPNE : (P_A, P_B), (P_A, N_B) and (N_A, P_B). If both banks offer the phone option, they set deposit rates equal to R and realize zero profits. If only one bank offers the phone option, its optimal deposit rate is such that the non-phonebank is driven out of the market.

2.3.3 Collusion, Fees, and Multiproduct Banks.

Assume banks can collude in the second stage by signing some binding agreement.[14] Then, universal phonebanking will result. Offering the phone option induces only a demand effect. Banks fully appropriate the marginal depositor's decrease in travelling costs per depositor. Alternatively, any deposit rate fixed by government, encourages universal phonebanking.

Introducing more complicated contracts in this model will not necessarily alter our results. Take the case of a fee per (type of) transaction and a deposit rate. In practice, some banks charge a fee for phonebanking. In our model, however, a higher deposit rate will fully compensate this fee. The fee per (type of) transaction acts as a perfect substitute for the deposit rate, since the number of transactions is fixed. Deposit rate and fees, however, are no longer perfect substitutes if the number of transactions is endogenous. Also, spatial discrimination is not an alternative. Depositors can circumvent this by making an agreement with someone living closer to the bank.

Suppose a phonebank offers its depositors the choice between two products. In contrast to the first product, the second allows the depositor to use the phone option. With each product, the bank associates a deposit rate. Nearby depositors are most willing to buy product one if its associated deposit rate is sufficiently higher. Note that these two products do not affect the location of the marginal depositor between banks. Therefore, the multiproduct phonebank can

[14]See Fershtman and Gandal (1994).

not improve on profits. In other words, it is optimal for banks to practice 'pure bundling'. [15] Heterogeneity in the number of depositors' transactions would allow banks better to discriminate among depositors. Differentiation between firms, however, seems to be more important for profitability than the possibility of discrimination (see Champsaur and Rochet (1990)).

2.4 Concluding Remarks.

We investigated the effects of phonebanking upon competition in the market for deposits. Our model shows that diverse equilibria occur. Two opposite effects are responsible for this diversity. First, the phone option reduces depositors' transaction costs. This creates a demand effect. Second, it encourages competition among banks through these lower transaction costs. This is the strategic effect. There is no phonebanking if the strategic effect dominates. Specialization appears for a relatively large demand effect and a moderate strategic effect. Universal phonebanking emerges if the demand effect overwhelms the strategic effect. The latter leads to tougher competition compared to no phonebanking. The competitive effects result in a tendency to underinvest in the phone technology. Depositors are best off with universal phonebanking.

We conclude with three possible extensions. First, if the phone option implies a reduction in processing costs, its attractiveness for banks increases. The competitive effects, however, remain. Second, one could make the number of financial transactions endogenous, following the Baumol-Tobin tradition (see Barro and Santomero (1972), Santomero (1979)). One expects the average outstanding amount of deposits to be higher in case a of a phonebank. Therefore, the attractiveness of offering the phone option increases. Third, our results also remain valid in a slightly different model with some depositor heterogeneity in terms of the number of transactions. Price competition is relaxed in the (P_A, N_B) case. However, price competition is enhanced in the (P_A, P_B) case.

[15] This stems with the statement that "a bank offers an indivisible array of services" (see Tirole (1988), p. 160).

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Chapter 3

Monopolistic Competition with a Mail Order Business

3.1 Introduction

This chapter investigates the equilibrium structure of an industry in which firms sell a homogeneous good at mill prices by two alternative methods. The first method consists of opening a retail store, which consumers can visit by paying a linear transportation cost. In the spatial price terminology, this method is called 'uniform Free-On-Board (FOB) pricing.'[1] The other method involves setting up a 'mail order business,' where consumers are served by paying a fixed cost, irrespective their initial location. The mail order business serves its consumers by some exogenous technology, e.g. a postal service. Both selling policies have in common that *none* of the firms bears transportation costs. They differ, however, in their impact on consumers' decisions. When a consumer buys at a retail store, his total expenditure equals the price *at* retail plus his transportation cost *to* the retail store. In contrast, all consumers buying at the mail order business have the same total expenditure. The store's selling policy implies uniformity of the price only at the store. The mail order business's

[1]In discussing this spatial price policy, Phlips (1983) remarks: "In any event, the net producer price (after deduction of freight) is the same whatever the destination, since at any point of delivery the delivered price is equal to the factory price plus actual carriage costs" (p. 28).

selling policy implies uniformity of the price — not only at the mail order business, but also at the place of delivery; that is, the consumer's home location. The fixed transportation cost implies that a price change affects every consumer equally. Location, therefore, becomes completely irrelevant when selling occurs by a mail order business. Markets in which consumers are served by stores and mail order businesses include the following: books, clothing, computers[2], flowerbulbs, photographic developing, records, banking and insurance products, and so on. This chapter aims at investigating the conditions and properties of an industry with the above characteristics.

The analysis adds a mail order business to the standard circle model à *la* Salop (1979). We characterize the protected monopoly,[3] the oligopoly and free-entry equilibrium, and the social optimum. It is never optimal for the monopolist to offer at the same time both selling policies, i.e. stores and a mail order business. With free-entry, only one store or mail order business is allowed per firm. If the set-up cost is large relative to the marginal transportation cost, no mail order business appears. However, at most one mail order business emerges in equilibrium. The mail order business competes in a non-localized fashion with all stores. The retail stores, however, compete in a localized way with the mail order business. The presence of a mail order business implies more competition, compared to the original Salop-model. As a result, a smaller number of firms is active in equilibrium. Finally, in the social optimum, it is never optimal to offer both selling policies at the same time.

The importance of mail order businesses varies between countries. In terms of per capita expenditures for 1991, it ranges from \$23 in Italy, to \$273 in the United States. As a percentage of the total turnover in the non-food retail trade in 1991, the mail order industry represented 5.1% in France, 4.7% in Sweden, and in the total retail trade, 4.7% in the Federal Republic of Germany.[4] These

[2]In 1991, 22% of all microcomputers in the US were sold through the mail (see McWilliams (1991)). In 1992, this figure increased to 30% (see Bhargava (1992))

[3]I.e., a monopolist 'who does not face the threat of entry' (Bonanno (1987), p.39).

[4]Source : *NRC Handelsblad*, June 30, 1993 and *European Mail Order Trade Association*, Key Figures 1991.

figures, however, take no account of the importance of the mail order business in a particular industry. They include industries where no mail order business exists. Excluding these industries will increase the mail order industry's share.

A mail order business can serve the entire market without affecting the consumer's cost of being served. This differs from uniform zone pricing in at least two ways. First, uniform zone pricing implies that every consumer within a well-defined region is charged the same price. Actual transportation costs, however, are borne by the firm. By choosing such a pricing policy, the firm faces a minimization problem for its total transportation costs. Second, the larger the market that is being served, the larger the average transportation cost is. Therefore, and in contrast with the mail order business, location matters under uniform zone pricing.

The economics literature on spatial structure in the retail trade where fixed versus linear transportation costs appear in a strategic context is rather scarce.[5] Heal (1980) studies a circle model in which consumers can buy either from the producer at the center or from a store on the circumference. Also the store, however, has to buy its products from the producer at the center. Due to increasing returns to scale in transportation costs, the outer store can develop a comparative advantage *vis-à-vis* the consumers. Lewis (1945) takes account of forms of retailing in which consumers do not visit the stores but order by telephone or by mail. He remarks that this kind of retailing is "convenient if the customer knows what he wants ..."(p.216). Henriet and Rochet (1991) discuss a circle model in which consumers can buy insurance either directly from the company (located at the center of the circle) or from one of its intermediaries (located on the circle). Buying from the direct writer implies a fixed cost for the consumer, regardless of his location. The alternative is to buy from the nearest

[5]There is, however, a considerable body of literature on endogenous (spatial) pricing policies. Spiegel (1982) demonstrates that sellers prefer the 'meet the competition' policy to uniform delivered pricing and mill pricing. Furlong and Slotsve (1983) show that a monopolist can increase profits when the choice is available between mill and uniform delivered pricing. In a different context, Bester (1993) analyzes whether posted prices or negotiated pricing will emerge in a market with quality uncertainty.

intermediary. They investigate the influence of different vertical restraints on the equilibrium outcome.

One recent article in the economics literature on mail order businesses versus retail stores is Michael (1994). He uses the theory of transaction costs to explain marketing channels. His analysis focusses on differences in costs of physical distribution and of informing the consumers in mail order businesses and retail stores. Changes over time in these costs significantly affect the sales of mail order businesses. The empirical results also support the assertion that a higher density of population makes retailing relatively more advantageous.

The subject of the chapter clearly differs from Thisse and Vives (1988), in which firms make strategic choices in terms of *spatial price* policy. Thisse and Vives consider two price policies: uniform FOB pricing and discriminatory pricing. They find "a robust tendency for a firm to choose the discriminatory policy" (p. 134). In footnote 8, they remark: "let us emphasize the fact that what we call here uniform pricing is different from uniform delivered pricing as defined in postage stamp systems." This chapter takes these two variants of uniform pricing as the available strategic choices for selling products.

In contrast with the economics literature, the marketing and retailing literature focusses on the mail order industry (see e.g. Darian (1987)). The central theme is on the relationship between demographic characteristics at the household level and (mail order) shopping behavior. This chapter studies the impact of selling by a mail order business on competition with retail stores. In the same line as the cited article by Thisse and Vives, the analysis stresses that "current business practices reflect a *strategic* positioning of firms in the market" (p. 122).[6]

The chapter is organized as follows. Section **3.2** presents the model. Section **3.3** analyzes the optimal structure for a monopolist. In order to focus on strate-

[6] As an example, Dell Computer Corp. sells exclusively through the mail. In contrast, Compaq Computer Corp. concentrates on selling through stores.

gic interactions between firms, Section **3.4** studies the oligopoly case. Section **3.5** considers the equilibrium market structure in a free-entry context. Section **3.6** addresses a welfare analysis. Finally, Section **3.7** contains some concluding remarks.

3.2 The Model

Consider a market for a homogeneous product. Marginal cost of production is constant and without loss of generality normalized at zero. Each firm, indexed by $i = 1, ..., N$, can choose from a set of two strategies to market the product. The first is the traditional way of opening a single store. At this store, consumers are charged a uniform mill price $p_i \geq 0$. Each consumer located at distance z from the store, bears the linear transportation cost $tz \geq 0$. We use the Salop (1979) circle model, where firms are located equidistant from each other. The second strategy is to open a mail order business, where consumers can order the product (by mail) at a mill price $q_i \geq 0$ plus a non-negative fixed cost φ (e.g. the price of the stamp) for sending the product to the consumer's location. This fixed cost φ is assumed to be independent of one's location and not susceptible to (strategic) manipulation by any of the players.[7] One possible interpretation is that the mail order business is located at the center of the circle. The radius of the circle then represents the fixed cost φ.

There is a unit mass of consumers whose initial locations are uniformly distributed on a circle with density one. The consumers buy from that firm that offers the lowest full price, i.e. mill price plus fixed or linear transportation cost. Each consumer has the same reservation price r and buys at most one unit of the good.

[7]The model assumes that price discrimination based on the consumer's address is illegal. This seems reasonable if the analysis concentrates on competition within one country.

3.3 Monopoly

Consider a protected monopolist who can make use of both selling policies. The monopolist decides on the number of stores on the circle, whether to set up a mail order business and, for each of these selling policies, what prices to charge. There is an identical positive set-up cost F for every mail order business and each store on the circle. Assume that $r \geq t$ so that, with only one store on the circle, it is in the monopolist's interest to serve the whole market. In addition, assume that $r > \varphi$, so that a mail order business can operate for some positive set-up cost.

Lemma 1: *If the monopolist can only open stores on the circle, his profit equals* $\max(0, r - \sqrt{2tF})$, *and* $\sqrt{0.5t/F}$ *is the optimal number of stores.*

Proof: Store i's marginal consumer, located at $\hat{x}$, is defined by the equation $p_i + t\hat{x} = r$. This implies that the monopolist's profit function is $2n_c\hat{x}(r - t\hat{x}) - n_cF$, with n_c the number of stores on the circle. Maximize this with respect to x, and the function is increasing as long as $r \geq 2t\hat{x}$. From the assumptions of symmetry and $r \geq t$, $0.5 \leq \hat{x}$ at $r = 2t\hat{x}$. Therefore, with $n_c \geq 1$ stores, the monopolist finds it optimal to serve the whole market, such that $\hat{x} = 0.5/n_c$, and the profit function becomes $r - 0.5t/n_c - n_cF$. Maximizing with respect to n_c yields an optimal number of $n_c^* = \sqrt{0.5t/F}$. After substitution, the profit equals $r - \sqrt{2tF}$. If this profit is larger than zero, the monopolist opens a number of $\sqrt{0.5t/F}$ stores on the circle. Otherwise, the monopolist stays out of the market. □

Lemma 2: *Assume that the monopolist cannot open stores on the circle. If* $r - \varphi \geq F$, *the monopolist opens one (and only one) mail order business. Otherwise, he opens no mail order business at all.*

Proof: If the monopolist opens $n_m \geq 1$ mail order businesses, his profit equals $(r - \varphi) - n_mF$. Therefore, opening more than one store would only reduce profits. If $r - \varphi - F \geq 0$, the monopolist opens only one mail order business. If F is such that profits are negative, the monopolist opens no mail order business at all. □

Proposition 1 contains the main result of this section. In contrast with Lemmas 1 and 2, we allow the monopolist to sell by stores and mail order businesses. The proposition assumes that both ways of selling are profitable.

Proposition 1: *(a) The monopolist opens a single mail order store if $\varphi + F \leq \sqrt{2tF}$; (b) he opens $\sqrt{0.5t/F}$ stores on the circle if $\varphi + F > \sqrt{2tF}$; (c) he never operates both types of business.*

Proof: If the monopolist can offer both types of selling policies, he chooses p_i, q_i, n_c, n_m and $\hat{x}$ so as to maximize

$$\pi(p_i, q_i, n_c, n_m, \hat{x}) = 2n_c\hat{x}p_i + \min(1, n_m)(1 - 2n_c\hat{x})q_i - (n_c + n_m)F$$

subject to $0 \leq \hat{x} \leq 0.5/n_c$ and $n_c, n_m \geq 0$. The variable p_i (q_i) denotes the price at a store on the circle (at a mail order business). The number of stores, n_c and n_m, are interpreted similarly. From the profit function, it is clear that at most one mail order business will be opened, if any. The consumer who is indifferent between buying at a store on the circle and at the mail order business is characterized by $q_i + \varphi = p_i + t\hat{x} = r$. Substitute this into the profit function, and differentiation with respect to $\hat{x}$ shows that the function is monotonically non-decreasing as long as $\varphi \geq 2t\hat{x}$. Since $0 \leq \hat{x} \leq 0.5/n_c$, $\hat{x} = \min(0.5/n_c, 0.5\varphi/t)$. If $\varphi/t \leq 1/n_c$, the profit function becomes

$$\tilde{\pi}(n_c, n_m) = 2n_c\frac{\varphi}{2t}(r - t\frac{\varphi}{2t}) + \min(1, n_m)(1 - 2n_c\frac{\varphi}{2t})(r - \varphi) - (n_c + n_m)F.$$

If, in equilibrium, the monopolist uses both selling policies, $(1 - 2n_c\varphi/2t)(r - \varphi) > n_mF$. After some rearranging, the function becomes

$$\tilde{\pi}(n_c, n_m) = r - \varphi - n_mF + n_c(\frac{\varphi^2}{2t} - F).$$

$\tilde{\pi}(\cdot, n_m)$ is non-decreasing in n_c as long as $\varphi \geq \sqrt{2tF}$. In this case, n_c can be increased up to the point where $\varphi/t = 1/n_c$. Every mail order business, therefore, cannot attract a positive market share. Since profits are decreasing in n_m, no mail order business is opened. In the other case, in which $\varphi < \sqrt{2tF}$, $\tilde{\pi}(\cdot, n_m)$ is strictly decreasing in n_c and no stores on the circle are opened. The optimal number of one mail order business results if profits are nonnegative.

If $1/n_c < \varphi/t$, the profit function becomes (after rearranging)

$$\tilde{\pi}(n_c, n_m) = r - \frac{t}{2n_c} - (n_c + n_m)F.$$

Since $\partial\tilde{\pi}(n_c, n_m)/\partial n_m < 0$, the optimal number of mail order stores equals zero. Differentiate with respect to n_c, and the optimal number n_c of stores on the circle equals $\sqrt{0.5t/F}$. If the resulting profit $r - \sqrt{2tF}$ is nonnegative, the monopolist opens a number of $\sqrt{0.5t/F}$ stores on the circle (see Lemma 1). The monopolist now makes the optimal choice by comparing both profits. If $r - \varphi - F > r - \sqrt{2tF}$, if and only if $\varphi + F > \sqrt{2tF}$, the monopolist prefers to open one and only one mail order business (see Lemma 2). Otherwise, he only opens the optimal number of stores on the circle. □

In words, the monopolist either opens retail stores *or* one mail order business. The intuition is as follows. Suppose opening a single mail order business is profitable. In addition, suppose the opening of one or more retail stores together with the mail order business yields extra profits, despite the additional fixed set-up costs. Then, ignoring integer problems, the monopolist's optimal decision is to serve the whole market by retail stores. In that case, the mail order business serves no consumers. Therefore, the monopolist opens no mail order business. If, on the contrary, opening the extra retail store does not yield extra profits, he opens a single mail order business.

3.4 Oligopoly

Let there be a fixed number of firms in the market, indexed by $i = 2, ..., N$. The model presented in Section 2 is analyzed as a two-stage game. In the first stage, firms decide on whether to become traditional stores (and consequently are appointed a position on the circle) *or* mail order businesses (and consequently have their location at the center of the circle). In the second stage, having observed each other's decision in the first stage and the corresponding location, they compete in prices. We solve the game for its Subgame Perfect Nash equilibria in pure strategies by the method of backward induction.

Before moving to the two relevant cases, consider the case in which more than one firm operates as a mail order business. A standard Bertrand result appears for these firms, since they are not differentiated at all with respect to each other. Price competition results in charging a price equal to marginal cost. Since set-up costs are strictly positive, in pure strategies at most one firm will open a mail order business. This results in two possible alternatives: (*i*) no firm operates a mail order business, and (*ii*) exactly one firm sells through the mail.

Alternative (*i*) coincides with Salop's circle model of product differentiation. All N firms decide to open a store on the circle. The distance between every pair of firms equals $1/N$. Suppose firm i chooses a price p_i, and that $\overline{p}$ is the price charged by the other firms. Then, a consumer located at distance x from firm i, with $x \in [0, 1/N]$, is indifferent between buying from firm i and its neighbor if

$$p_i + tx = \overline{p} + t(\frac{1}{N} - x). \tag{1}$$

The difference $(1/N - x)$ is the distance between the indifferent consumer's location x and the neighboring firm. Solving (1) for x, one obtains firm i's demand at both sides. Define profits as total demand times price, and firm i's profit equals

$$\pi_i(p_i, \overline{p}) = 2xp_i = \frac{\overline{p} - p_i + t/N}{t} p_i. \tag{2}$$

Optimizing this with respect to p_i, $p_i^* = 0.5(\overline{p} + t/N)$ is firm i's optimal price, given $\overline{p}$. By symmetry, set $p_i = \overline{p}$. This yields the symmetric solution, so that $p_i^* = p^* = t/N$.[8] Firm i's market share then becomes $1/N$. It follows that every firm's gross profit, expressed as a function of the number of firms N, equals

$$\pi_S^*(N) = \frac{t}{N^2}. \tag{3}$$

[8]This analysis also assumes that the market equilibrium lies in the competitive region of firm i's demand curve. That is, the reservation price $r \geq 3t/2$ (see Salop (1979) for the exposition).

Expression (3) will be referred to as the *S-equilibrium* profit.

In alternative (ii), only one firm decides to become a mail order business; the other $(N-1)$ firms are equally spaced around the circle. Each of the $(N-1)$ firms on the circle is at distance $1/(N-1)$ from its two neighbors on the circle. Each firm i on the circle now faces three competitors: the two nearest ones on the circle *and* the mail order business. In between every two neighboring firms on the circle, two indifferent consumers can be defined. One is indifferent between firm i and its neighboring firm on the circle. Given a price $\overline{p}$ charged by this competitor on the circle, this indifferent consumer is located at y, where

$$p_i + ty = \overline{p} + t(\frac{1}{(N-1)} - y) \tag{4}$$

as long as $y \leq 1/(N-1)$. The other is indifferent between firm i and the mail order business. Given a price $\overline{q}$ charged by the mail order business, this indifferent consumer is located at z such that

$$p_i + tz = \overline{q} + \varphi. \tag{5}$$

Figure 1 clearly illustrates that if $y \leq z$, the mail order business gains no positive market share, and consequently, zero profits. If $y > z$, the mail order business can serve a positive share of the market (see Figure 2).

Firm i's total demand D_i is defined as

$$D_i(p_i, \overline{p}, \overline{q}) \equiv \begin{cases} 2y & \text{if } \; 0 \leq p_i \leq 2(\overline{q}+\varphi) - (\overline{p} + t/(N-1)) \\ 2z & \text{if } \; 2(\overline{q}+\varphi) - (\overline{p} + t/(N-1)) \leq p_i \leq \overline{q}+\varphi \\ 0 & \text{if } \; \overline{q}+\varphi \leq p_i. \end{cases} \tag{6}$$

Then, profits for firm i on the circle are

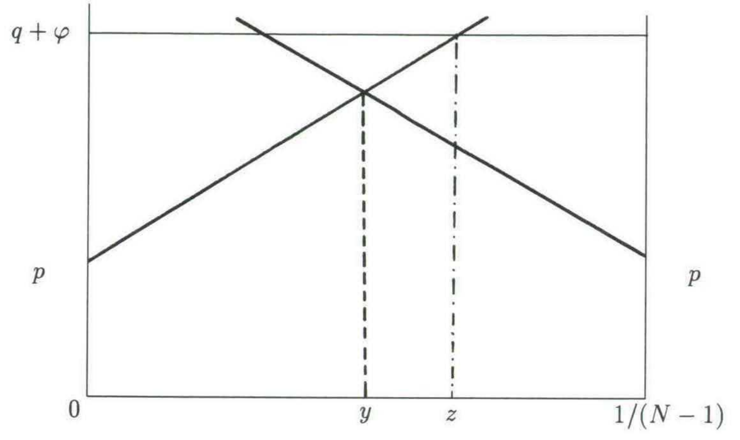

Figure 1: The mail order business has no market share.

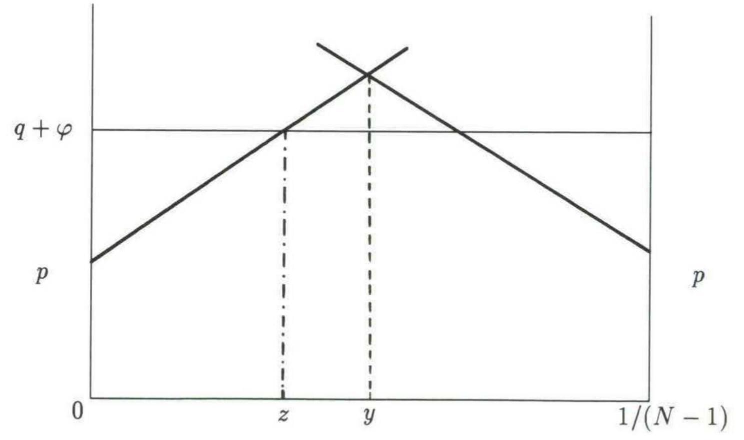

Figure 2: The mail order business has a positive market share.

$$\pi_i(p_i, \overline{p}, \overline{q}) = D_i(p_i, \overline{p}, \overline{q})p_i. \tag{7}$$

Since the mail order business's location is in the center of the circle, it faces $(N-1)$ neighbors. For a given price $\overline{p}_i$ charged by every firm i on the circle, the mail order business first competes for the consumers in the middle between every two firms on the circle, i.e. at distance $1/(2(N-1))$. The consumer, who is indifferent between buying at firm i or at the mail order business charging a price q, is located at $\tilde{z}$ such that

$$\overline{p_i} + t\tilde{z} = q + \varphi. \tag{8}$$

Equation (8) applies for each side of all $(N-1)$ firms on the circle. Therefore, the mail order business's total demand D_M is defined as

$$D_M(\overline{p}_i, q) \equiv \begin{cases} 0 & \text{if } q \geq \overline{p}_i + t/2(N-1) - \varphi \\ (\frac{2(N-1)}{t}(\overline{p}_i - \varphi - q + \frac{t}{2(N-1)}) & \text{if } \overline{p}_i - \varphi \leq q \leq \overline{p}_i + \frac{t}{2(N-1)} - \varphi \\ 1 & \text{if } q \leq \overline{p}_i - \varphi. \end{cases} \tag{9}$$

The profit for the mail order business equals

$$\pi_M(\overline{p}_i, q) = D_M(\overline{p}_i, q)q. \tag{10}$$

Expression (10) is continuous and quasi-concave in q. Optimizing expression (7) with respect to p_i, and expression (10) with respect to q, the first-order conditions are

$$p_i = \frac{\overline{q} + \varphi}{2}, \tag{11}$$

$$q = \frac{\overline{p_i} - \varphi + t/2(N-1)}{2} \tag{12}$$

if all firms on the circle and the mail order business have a positive market share. Using the assumption of symmetry ($p_i = \overline{p_i} = p$) for the firms on the circle and using $\overline{q} = q$ for the mail order business, define the Nash-equilibrium (p^*, q^*) of the pricing-game by a mill price of

$$p^* = \frac{2\varphi + t/(N-1)}{6} \tag{13}$$

at every store on the circle, and a mill price of

$$q^* = \frac{t/(N-1) - \varphi}{3} \tag{14}$$

at the mail order business. If $t/(4(N-1)) > \varphi$, the price the mail order business charges is higher than the firms on the circle charge. For higher values of φ, lower prices result. The price the mail order business and the firms on the circle charge are always lower compared to the situation in which firms can operate only on the circle.

Substitute expressions (13) and (14) into (7) and (10) to see that the profits expressed as a function of the number of firms N are

$$\pi_C^*(N) = \frac{1}{18t}(\frac{t}{(N-1)} + 2\varphi)^2 \tag{15}$$

for every firm on the circle, and

$$\pi_M^*(N) = \frac{2(N-1)}{9t}(\frac{t}{(N-1)} - \varphi)^2 \tag{16}$$

for the mail order business. The expressions (15) and (16) will be referred to as the *M-equilibrium* profits.

Before starting with the main proposition of this section, we define the function $h(\cdot)$ by

$$h(N) \equiv t(\frac{1}{N-1} - \frac{3}{N\sqrt{2(N-1)}}). \tag{17}$$

The function $h(\cdot)$ defines the relationship between φ and N in the $S-$ and the $M-$equilibrium. Expression (17) is non-negative for all $N \geq 3$; furthermore, $h(3) = 0$, $h(\infty) = 0$ and $h(2) < 0$.

Proposition 2 : *(a) If $\varphi \leq h(N)$, then exactly one firm operates a mail order business and the remaining firms locate on the circle. (b) Otherwise, the unique equilibrium in pure strategies is that all firms locate on the circle.*

Proof : Consider firm i's profit if all other firms are located on the circle. If firm i decides to locate on the circle, its profit equals t/N^2, as can be seen from expression (3). If, however, firm i decides to become a mail order business, its profit is $2((N-1)/9t)(t/(N-1)-\varphi)^2$ by (16). Therefore, firm i finds it optimal to start up a mail order business if $t/N^2 \leq 2((N-1)/9t)(t/(N-1)-\varphi)^2$. This condition is equivalent to $\varphi \leq h(N)$. Given firm i's decision to become a mail order business, the remaining firms on the circle have a profit of $\pi_C^*(N) = (1/18t)(t/(N-1)+2\varphi)^2$ by (15). It is not profitable for any of the firms on the circle to switch to the center and become mail order businesses since $\pi_C^*(N) > 0$. This establishes part (a). If, however, $t/N^2 > 2((N-1)/9t)(t/(N-1)-\varphi)^2$, the opposite inequality holds, i.e. $\varphi > h(N)$. Firm i locates on the circle and no other firm switches to the center. This establishes part (b). □

Proposition 2 implies that if some firm sets up a mail order business, the cost of sending the good through the mail should be small enough. In that case, the parametric constellations result in an *M*-equilibrium. Since φ is non-negative, and in an *M*-equilibrium not larger than $h(N)$, we have that $h(N) \geq 0$. From the properties of this function, the lower bound on the number of firms in an *M*-equilibrium is $N \geq 3$. The intuition is that a firm has an incentive to open a mail order business only if its profit as a firm on the circle is relatively small. In an *M*-equilibrium, the mail order business foregoes some market power by a decrease in the equilibrium prices. Therefore, a single firm on the circle has no incentive to become a mail order business if the gain in market share is not large enough. The mail order business has a larger market share in comparison with the firms' market shares in the *S*-equilibrium. Indeed, $\varphi \leq h(N)$ implies that $(2(N-1)/3t)(t/(N-1)-\varphi) > 1/N$. As φ increases from 0 to $h(N)$, the mail order business's market share decreases from 2/3 to $\sqrt{2(N-1)}/N$. The total market share for the firms on the circle increases from 1/3 to $1-\sqrt{2(N-1)}/N$. The mail order business's market share, therefore, always exceeds that of the firms on the circle. For low values of N, the equilibrium mill price at a store is lower than at the mail order business. For high values of N, the opposite relationship holds.

In the S-equilibrium, each firm competes with its two neighbors in only a direct way. The cross-price elasticities are positive for neighboring firms, but zero for all other firms. Using the terminology of Anderson and de Palma (1990), there is localized competition. In the M-equilibrium, the firm in the center competes directly with every firm on the circle. Clearly, this generates some form of nonlocalized competition, as the cross-price elasticity $(\partial D_i/\partial q)(q/D_i)$ is positive and identical for all i. The mail order business shoulders itself in between every firm on the circle. The firms on the circle have only one direct competitor, i.e. the mail order business. A small change in their own price affects only the mail order business's market share. The cross-price elasticity $(\partial D_M/\partial p_i)(p_i/D_M)$ is positive and identical for all i. The cross-price elasticity $(\partial D_i/\partial p_j)(p_j/D_i)$ equals zero for all $j \neq i$. They are engaged in some form of localized competition. Figure 3 shows an example with $N = 7$. The bold lines represent the mail order business's market share.

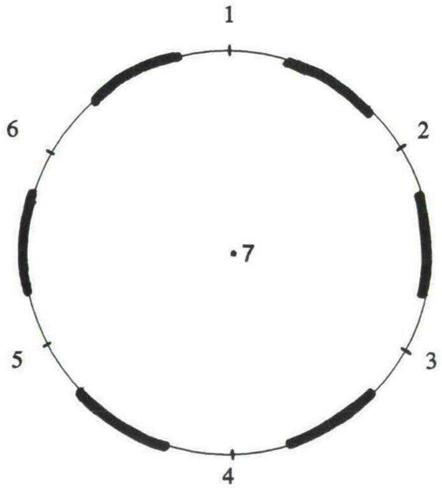

Figure 3: Market shares in an M-equilibrium with $N = 7$.

The following proposition compares firms' profits in Salop's (1979) model with firms' profits on the circle if a mail order business is active.

Proposition 3: *Firms on the circle earn higher profits if no mail order business operates:* $\pi_S^*(N) > \pi_C^*(N)$.

Proof: Expression (3) is strictly larger than expression (15) if and only if $\varphi < t(3/\sqrt{2}N - 1/2(N-1))$. Compare the right-hand side of this inequality with $h(N)$ to see that $t(3/\sqrt{2}N - 1/2(N-1)) > h(N)$ if and only if $\sqrt{2} > N/(N-1) - \sqrt{2/(N-1)}$. For all $N \geq 2$, the right-hand side of the latter inequality is an increasing function. By applying l'Hôpital's rule, it reaches its maximum of 1 for N approaching infinity. Since $\varphi \leq h(N)$ in the *M*-equilibrium, the result follows. □

Proposition 3 holds because for fixed N prices in the *M*-equilibrium are lower than they are in the *S*-equilibrium. As already noted before, the mail order business has a larger market share *vis-à-vis* the firms' market shares in the *S*-equilibrium. Therefore, lower prices and market shares for firms on the circle result in lower profits.

3.5 Free-Entry Equilibrium

This section studies entry into the industry. In order to have a finite number of firms, we introduce a non-negative fixed set-up cost of production, say F. The oligopoly two-stage game of the previous section is now enlarged by an additional stage. The three-stage game proceeds as follows. In the first stage, each firm decides whether or not it will enter the market. Having observed the number of firms entering the market, the entrants play the two-stage game of the previous section. Those who do not enter receive zero profits.

The previous section established that the *S*- and *M*-equilibrium are possible candidates satisfying the subgame perfectness condition. Our Subgame Perfect equilibrium of free-entry requires that entering firms earn non-negative profits, and all other firms anticipate non-positive profits when entering. This motivates the following two definitions.

Definition 1: N_S^* is the number of firms in a free-entry S-equilibrium if (i) $\pi_S(N_S^*) = F$; and (ii) $\pi_S(N_S^*) \geq \pi_M(N_S^*)$.

Condition (i) ensures that all firms make zero profits. It implies that $N_S^* = \sqrt{t/F}$, by (3). Condition (ii) guarantees that with the equilibrium number of firms in the market, no firm wants to switch to a mail order business. The condition is equivalent to $\varphi \geq h(N_S^*)$ (i.e., the condition in Proposition 2). In the free-entry S-equilibrium, therefore, $\varphi \geq h(\sqrt{t/F})$.

Definition 2: N_M^* is the number of firms in a free-entry M-equilibrium if (i) $\pi_C(N_M^*) = F$; and (ii) $\pi_M(N_M^*) \geq \pi_S(N_M^*)$.

The first condition ensures that all firms on the circle make zero profits. Proposition 3 established that $\pi_C(N) < \pi_M(N)$. It follows that only the firms on the circle must satisfy the zero-profit conditions for free-entry. The second condition guarantees that with the equilibrium number of firms in the market, exactly one firm wants to switch to the mail order business. Define the following function:

$$g(N) \equiv \frac{1}{2}(\sqrt{18tF} - \frac{t}{N-1}). \tag{18}$$

The function $g(\cdot)$ is increasing and, by (18), the equality $g(N_M^*) = \varphi$ represents the zero-profit condition for the firms on the circle. Condition (ii) in Definition 2 is equivalent to $\varphi \leq h(N_M^*)$. Therefore, N_M^* satisfies the requirements (i) and (ii) of Definition 2 if and only if $g(N_M^*) = \varphi \leq h(N_M^*)$. [9] The next proposition compares the number of firms in the free-entry equilibrium of Salop's (1979) model with the number of firms if a mail order business is active.

[9] Assume that $F < t/18$, such that with $N_M^* = 2$, a firm on the circle is not prevented from entering the market.

Proposition 4: *Let $\pi_S(N_S^*) = \pi_C(N_M^*) = F$. Then $N_S^* > N_M^*$. That is, the free-entry equilibrium number of firms is larger when there is no mail order business.*

Proof: Suppose $N_S^* \leq N_M^*$. Since expression (15) is decreasing in N, $\pi_C^*(N_M^*) \leq \pi_C^*(N_S^*)$. Proposition 3 implies that in case there is a mail order business, the profits of the firms on the circle are smaller compared to the number under the free-entry S-equilibrium. Therefore, $\pi_C^*(N_S^*) < \pi_S^*(N_S^*)$. The free-entry S-equilibrium requires that $\pi_S^*(N_S^*) = F$. But then $\pi_C^*(N_M^*) < F$, and N_M^* cannot be the number of firms under a free-entry equilibrium. A contradiction. □

Proposition 4 states that the number of firms in the free-entry S-equilibrium is larger than it would be in the free-entry M-equilibrium. Therefore, the market with a mail order business is more competitive. This accords with the result that nonlocalized competition yields fewer firms in a free-entry equilibrium than it would in localized competition (see Deneckere and Rothschild, 1992). The conditions for an S- and M-equilibrium are now analyzed.

Lemma 3: *(i) $h(3) = 0$ and $h(N) > 0$ for all $N > 3$; (ii) $g(3) \geq 0$ if and only if $t/F \leq 72$; (iii) $g'(N) > h'(N)$ for all $N > 3$; (iv) $g(N) > h(N)$ for all N large enough.*

The proof of Lemma 3 is relegated to the Appendix. From Lemma 3, the following results can be obtained.

Proposition 5: *(i) N_M^* is increasing in φ, and decreasing in F; (ii) If a free-entry M-equilibrium exists, then $N_M^* \geq 3$.*

Proof: (i) Inspection of expression (18) yields the comparative static results; (ii) From Lemma 3, $g'(N) > 0$. Lemma 3 establishes that no M-equilibrium exists if $g(3) > 0$. Since $\varphi \geq 0$, $N_M^* \geq 3$ if an M-equilibrium exists. □

An increase in φ implies more friction in the market and prevents the mail order business from decreasing the prices drastically. Therefore, more firms can enter the market.

Proposition 6: *(i) Let $F \leq t/72$; then there exists a $\overline{\varphi} > 0$, such that an M-equilibrium with free-entry exists if and only if $0 \leq \varphi \leq \overline{\varphi}$. (ii) If $F > t/72$, free-entry does not result in an M-equilibrium.*

Proof: (i) By Lemma 3, there exists an $\overline{N}$ such that $h(\overline{N}) = g(\overline{N}) \equiv \overline{\varphi}$. Since $g(3) \leq 0$ and $g'(N) > h'(N)$ for all $N > 3$ with $g'(N) > 0$, for $\varphi \leq \overline{\varphi}$ there is a unique N such that $g(N) = \varphi < h(N)$; (ii) Since $h(3) = 0$ and $g'(N) > h'(N)$ for all $N \geq 3$, the condition for a free-entry *M*-equilibrium $0 \leq g(N) = \varphi \leq h(N)$ (as stated in Definition 2) can never be satisfied. □

If the fixed set-up cost is too large compared to the marginal cost of transportation, the zero-profit condition for firms on the circle cannot be satisfied.

Proposition 7: *Let N_M^* and N_S^* satisfy the zero-profit conditions of the free-entry equilibrium. (a) Let $h(N_M^*) < h(N_S^*)$. Then, (i) the S-equilibrium with free-entry is unique if $\varphi \geq h(N_S^*)$; (ii) the M-equilibrium with free-entry is unique if $\varphi \leq h(N_M^*)$; (iii) no pure strategy equilibrium exists if $h(N_M^*) < \varphi < h(N_S^*)$. (b) Let $h(N_S^*) \leq h(N_M^*)$. Then, (i) the M-equilibrium is unique if $\varphi < h(N_S^*)$; (ii) the S-equilibrium is unique if $\varphi > h(N_M^*)$; (iii) the free-entry S-equilibrium and the free-entry M-equilibrium coexist if $h(N_S^*) \leq \varphi \leq h(N_M^*)$.*

Proof: *(a)* (i) from Definition 1, a free-entry *S*-equilibrium exists, since $\varphi \geq h(N_S^*)$ holds, while condition (ii) of Definition 2 is violated; (ii) Similarly, no free-entry *S*-equilibrium exists, since condition (ii) of Definition 1 is violated, while Definition 2 holds; (iii) In the same fashion, both conditions for the free-entry *S*- and *M*-equilibrium are violated if $h(N_M^*) < \varphi < h(N_S^*)$. Part *(b)* can be proven in a similar fashion. □

Figure (4a) plots part *(a)* of Proposition 7. As a numerical example, take $t = 100$ and $F = 1$. It follows that $N_S^* = 10$, and so $h(N_S^*) \simeq 4.04$. If $\varphi = h(N_S^*)$, $N_M^* \simeq 3.91$ and $h(N_M^*) \simeq 2.56$, the free-entry *S*-equilibrium is thus unique, since $h(N_M^*) < h(N_S^*) = \varphi$. For every $\varphi > 4.04 \simeq h(N_S^*)$, we are in the free-entry

S-equilibrium. If $\varphi = 1$, the only equilibrium is the free-entry M-equilibrium, since $N_M^* \simeq 3.47$, and thus $\varphi \leq h(N_M^*) \simeq 1.59 \leq h(N_S^*)$. If, however, $\varphi = 2$, $h(N_M^*) \simeq 1.9$, and no equilibrium exists, since $h(N_M^*) < \varphi < h(N_S^*)$.

Figure (4b) plots part *(b)* of Proposition 7. As a numerical example take $t = 200$ and $F = 1$. It follows that $N_S^* \simeq 14.14$ and $h(N_S^*) \simeq 3.48$. If $\varphi = 1$, then $N_M^* \simeq 4.45$, and so $h(N_S^*) < h(N_M^*) \simeq 6.64$ and the free-entry M-equilibrium is unique. If φ is large enough, the free-entry S-equilibrium is unique; e.g. $\varphi = 10$, $N_M^* = 6$ and so $h(N_S^*) < h(N_M^*) \simeq 8.37 < \varphi$. For intermediate values of φ, the free-entry M- and S-equilibrium may co-exist; for instance if $\varphi = 4$, it follows that $N_M^* \simeq 4.85$, and so $h(N_S^*) < \varphi < h(N_M^*) \simeq 7.36$.

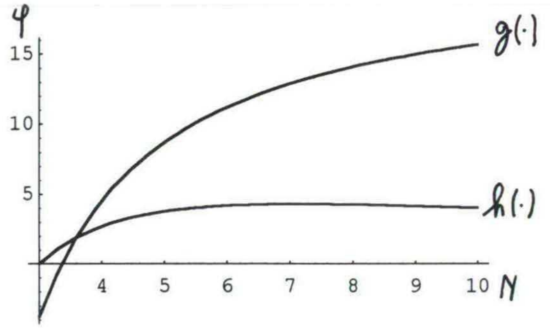

Figure (4a): The S- and M-equilibrium with $t = 100$ and $F = 1$.

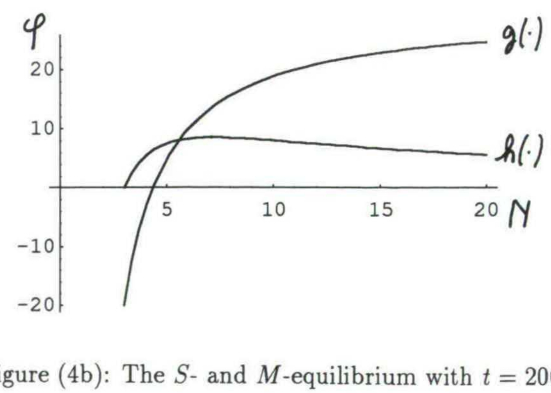

Figure (4b): The S- and M-equilibrium with $t = 200$ and $F = 1$.

3.6 Welfare Analysis

From the social planner's point of view, the socially optimal selling policy minimizes the sum of total transportation costs and set-up costs of production. If the social planner can only open stores on the circle, as in Salop (1979), he opens $\sqrt{t/4F}$ stores. Straightforward calculations show that total costs equal $\sqrt{tF}$. If the social planner can only open n_m mail order businesses, it is optimal to open only one. This generates a social cost of $\varphi + F$.[10]

Proposition 8: *The social planner opens $\sqrt{t/4F}$ stores on the circle if $\varphi + F > \sqrt{tF}$. Otherwise, he opens one mail order business.*

Proof: If the social planner can offer both selling policies, he has to minimize

$$W(n_c, n_m, x) = (\frac{1}{2n_c} - x)2n_c\varphi + 2n_c\frac{tx^2}{2} + (n_c + n_m)F \tag{19}$$

subject to $0 \leq x \leq 0.5/n_c$; $n_c, n_m \geq 0$. The variable x is the distance of the indifferent consumer between two neighboring stores on the circle.
Optimizing this expression with respect to x, its optimal value x^* satisfies $x^* = \min(\varphi/t, 0.5/n_c)$. Substituting this back into expression (19) , the optimization problem reduces to

$$\begin{aligned}\widetilde{W}(n_c, n_m) \;=\; & (\frac{1}{2n_c} - (\min(\frac{\varphi}{t}, \frac{1}{2n_c})))2n_c\varphi + \\ & 2n_c(\min(\frac{\varphi}{t}, \frac{1}{2n_c}))t\frac{\min(\frac{\varphi}{t}, \frac{1}{2n_c})}{2} + (n_c + n_m)F. \end{aligned} \tag{20}$$

If $\varphi/t \leq 0.5/n_c$, expression (20) simplifies to

$$\widetilde{W}(n_c, n_m) = \varphi - n_c(\frac{\varphi^2}{t} - F) + n_m F.$$

The term $(\varphi^2/t - F)$ is the marginal contribution of a store to the total cost minimization. If $\varphi^2/t - F \leq 0$, if and only if $\varphi \leq \sqrt{tF}$, n_c should be as small as possible, i.e. 0. This results in a total welfare cost of $\varphi + F$ if $n_m = 1$.

[10] The cost of transportation by mail equals φ per unit of delivery. Since the technology operates with or without a mail order business, its cost is only marginal.

If, however, $\varphi^2/t - F > 0$, n_c should be as large as possible. Having a maximum at $t/2\varphi$, the expression becomes

$$\widetilde{W}(n_c, n_m) = \frac{\varphi}{2} + n_m F + \frac{tF}{2\varphi}. \tag{21}$$

Since $\varphi = 0.5t/n_c$, the constraint is binding. Substituting this into expression (21), the social planner faces the following minimization problem:

$$\widetilde{W}(n_c, n_m) = \frac{t}{4n_c} + (n_c + n_m)F \tag{22}$$

Expression (22) coincides with the minimization problem the social planner faces if $\varphi/t > 0.5n_c$ and yields an optimal outcome of $(n_c^*, n_m^*) = (\sqrt{t/4F}, 0)$. This outcome results in a total welfare cost equal to $\sqrt{tF}$. The social planner, therefore, prefers to open the optimal number of stores n_c^* if $\varphi + F > \sqrt{tF}$. Otherwise, he opens one mail order business. □

Proposition 8 tells us that, similar to the monopolist, the social planner will operate only one type of business. Indeed, suppose $\varphi + F < \sqrt{tF}$ and the social planner opens a store in addition to the mail order business. The consumer located at $x = \varphi/t$ from the store is indifferent between the mail order business and the store. The total transportation costs are therefore reduced by φ^2/t. If the additional fixed set-up cost $F > \varphi^2/t$, it is not worthwhile to open the store. Since $\varphi + F < \sqrt{tF}$, it is not optimal to open this additional store. Similarly, if $F \le \varphi^2/t$, it follows that $\varphi + F > \sqrt{tF}$. In other words, it is not optimal to open a mail order business in addition to the stores on the circle. Also, the surplus per consumer is independent of the number of mail order businesses. Therefore, the social planner opens only one. Of course, a higher t and lower φ make the mail order business constellation more likely. Any increase in F favors the mail order business constellation if $n_c^* > 1$.

Propositions 1 and 8 make it possible to compare the monopolist and the social planner. Figure 5 graphically illustrates this comparison in (φ, F)–space. If $\varphi < \sqrt{tF} - F$, the social planner and monopolist open only one mail order business (region I). If $\varphi > \sqrt{2tF} - F$, both open the optimal number of stores (region III). For any $\sqrt{tF} - F \leq \varphi \leq \sqrt{2tF} - F$, the social planner opens the optimal number of stores on the circle, whereas the monopolist opens only one mail order business (region II). The intuition is that the social planner is interested in the average consumer, whereas the monopolist seeks to serve the marginal consumer. Therefore, the monopolist locates closer to the marginal consumer than does the social planner. A higher critical φ supports this idea. It is, therefore, of no surprise that the social planner opens less stores compared to the monopolist.

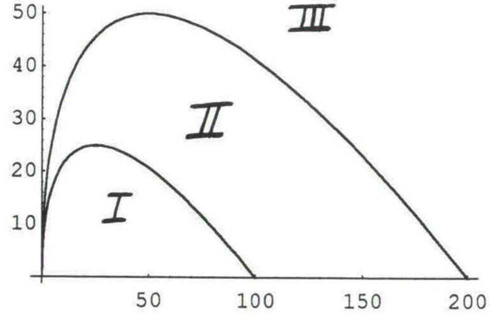

Figure 5: Comparison between the social planner and the monopolist in (φ, F)-space $(t = 100)$.

The oligopoly and free-entry analysis showed that firms on the circle and a mail order business can coexist as an equilibrium. From Proposition 4, the number of firms in the free-entry S-equilibrium is larger compared to the M-equilibrium. This result weakens the familiar proposition that competition creates too much variety compared to the social optimum (see e.g. Salop (1979)). Continuing the numerical example, take $t = 100$, $F = 1$ and $\varphi = 1$. The number of firms in a Salop model equals 10, whereas only 3.47 firms (of which one as a mail order business) enter the market in the free-entry M-equilibrium. The monopolist opens only one mail order business. The free-entry M-equilibrium is suboptimal, since firms on the circle and a mail order business appear. In the social optimum, only one mail order business appears.

3.7 Conclusion

This chapter examined a spatial model on the circle where firms can either sell by a store or by a mail order business. Selling by a store implies a transportation cost for the consumers that increases with distance. In contrast, selling by a mail order business implies a fixed cost for the consumer, regardless of his location. In a free-entry context, at most one mail order business emerges. Competition increases and, as a consequence, the number of firms entering the market is lower, compared to the well-known Salop model. The mail order business competes with every firm on the circle, and therefore engages in non-localized competition. The stores on the circle face only one local competitor – –i.e. the mail order business. In the monopoly and the social optimum, stores and mail order businesses never appear together.

The result that at most one mail order business will emerge, of course, depends on assumption of homogeneous goods. In addition, there is the implicit assumption that consumers are perfectly informed about the existence of the mail order business. The model, however, can be modified by introducing advertisements, for example. Then, consumers are informed about the existence of the products offered. A mail order business attracts consumers depending on its advertising costs. In addition, this model assumes that consumers are perfectly aware of the quality of the product. If quality inspection before purchase is costly, a mail order business may have a strategic disadvantage. Finally, in a multi-country framework, the mail order businesses may be able to use consumers' addresses as a price discriminating device (— yet another interesting topic for future research).

3.8 Appendix

Proof of Lemma 3:

(i) $h(3) = 0$, obvious. $h(N) > 0$ for all $N > 3$ if and only if $N/(\sqrt{N-1}) > 3/\sqrt{2}$. Since $N/(\sqrt{N-1})$ is strictly increasing in N and equals $3/\sqrt{2}$ at $N = 3$, the result follows.

(ii) $g(3) \geq 0$ if and only if $t/F \leq 72$. From evaluation of expression (18) at $N = 3$, we find that $t/F = 72$. Since $g(N)$ is strictly increasing, the result follows.

(iii) $g'(N) - h'(N) > 0$ for all $N > 3$ if and only if $3t/(2(N-1)^2) > 3\sqrt{2}t(3N - 2)/(4N(N-1)^{\frac{3}{2}}N)$. It can easily be checked that this holds for all $N > 3$.

(iv) From (i) and (ii), $h(3) = 0$ and $g(3) \leq 0$ if and only if $t/F \geq 72$. Since $g'(N) > 0$ for all finite N and $g'(N) - h'(N) > 0$ for all $N > 3$ from (iii), $g(N) > h(N)$ for some $N > 3$. If $t/F < 72$, then $g(3) > h(3) = 0$. $\square$

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Chapter 4

Price Competition between an Expert and a Non-expert

4.1 Introduction

This chapter characterizes price competition in a special type of duopoly where consumers look for a successful match. The two firms are denoted as the expert and the non-expert. The consumers' match with the expert's good is always successful. The non-expert's good successfully matches the consumers' needs only with some commonly known exogenous probability. With the remaining probability the match is not successful. In other words, the non-expert sells an experience good: its quality is known only after consumption. All consumers attach a common positive value to a successful match, but no value in case the match was unsuccessful. They seek to minimize their expected expenditures. Therefore, they can go immediately for the expert's good and only face one purchase decision. Or, they choose for the non-expert's good, anticipating the risk of an unsuccessful match. In the event of a such a bad match, these consumers re-enter the market since bygones are forever bygones. If the non-expert fails to successfully match a consumer's needs, however, another visit at his store yields no success with probability one. That is, the non-expert's matching technology is characterized by perfect correlation. Therefore, these consumers' only choice is to purchase the expert's good. Summing up, the consumers make a purchase decision under uncertainty: going directly for the expert's good may be unnecessary, while buying at the non-expert may turn out to be a pure waste.

The model applies to the following markets. The first example is competition between a craftsman and a handyman. A craftsman always repairs successfully. By contrast, a handyman's repair technology is imperfect. A consumer, therefore, may turn to the craftsman after experiencing an unsuccessful match at the handyman. Second, the model can also be interpreted as competition between a repair shop and a shop selling new goods. A consumer's decision to patch up his broken car depends on the probability of successful repair, the price of patching up, and the price of a new car. Third, the model also shows some insight regarding price competition between a store selling low quality and another store selling high quality products: only the low quality store sells a product that may break down or is incompatible with another product with some probability. Finally, there is the market for medical services. General practitioners argue that a mandatory referral prevents patients from a needless visit to the more expensive specialist. The latter argue, however, that if patients are allowed to visit the specialist without the mandatory referral of the general practitioner, it prevents them from making two visits.

We study this problem in a simple horizontal differentiation model and use Hotelling's line as our framework. The consumers are uniformly distributed along the unit interval.[1] The two firms are located at the extremes of this interval; the non-expert is at the left extreme and the expert at the right extreme. The analysis shows that two types of equilibria can occur. In the first equilibrium, some consumers prefer to first visit the non-expert while others directly visit the expert. This happens when the horizontal differentiation is high enough and the non-expert's repair technology is sufficiently successful. The intuition is that the expert's residual demand of "failures" becomes very small when the non-expert becomes a close substitute. This equilibrium is in pure strategies.

[1]In the medical services example, the horizontal differentiation component can be interpreted as consumers' differences in threshold fear.

Both firms adopt an "agressive-pricing" strategy since the expert competes in a direct way with the non-expert. In the second type of equilibrium, the expert adopts a mixed strategy where he charges with some probability a low price. With the remaining probability, he charges the monopoly price. In this event, all consumers first visit the non-expert. The non-expert, however, adopts a pure strategy given the expert's mixed strategy. In this "mixed-pricing" equilibrium, the expert's profit is independent of the actual price he charges. This equilibrium occurs for low enough degrees of horizontal differentiation and low enough probabilities of successful repair. When the non-expert's probability of successful repair approaches a critical value, the expert charges his monopoly price with certainty. In this limiting case, all consumers first visit the non-expert with certainty. In this event, the expert only serves "failures". That is, only those consumers who had an unsuccessful match at the non-expert patronize the expert. In this limiting equilibrium, the firms adopt a "timid-pricing" strategy: the non-expert can charge a high price since the expert finds it optimal to serve only the failures. The welfare analysis makes clear that when the expert incurs a cost-disadvantage, the market outcome in pure strategies results in too many consumers directly visiting the expert. The opposite happens without cost differences.

Meurer and Stahl (1994) consider a market with two firms, each selling a horizontally differentiated good. In their model, consumers either experience a good or a bad match. Consumers experiencing a bad match, however, never re-enter the market. This chapter, in contrast, allows consumers to re-enter the market after experiencing a bad match. The consumers are horizontally differentiated and two firms sell a vertically differentiated product. The probability of a successful match serves as a measure for quality: at equal expenditures every consumer prefers the expert's good. Meurer and Stahl's (1994) examples apply in this model if we make some modifications: e.g. low quality machinery and equipment may break down and become irreparable. The value of a good match after this breakdown, however, may still be positive. Buying high quality after the breakdown of the low quality machinery, therefore, can be justified. In a somewhat different context, Lal and Matutes (1989) consider price competition between two stores, each selling the same assortment of two independent goods. In their model, two types of consumers exist. In one equilibrium, the two stores charge the same full price for the assortment, but different prices for each good in the bundle. Poor consumers buy each product at the store charging the cheapest price and, therefore, re-enter the market after their first purchase at one of the two stores. Rich consumers, however, never shop around; they never re-enter the market. In this chapter, there is only one type of consumer. In addition, the stores sell vertically differentiated goods. Some consumers visit both firms as they find it ex ante optimal to try out the non-expert's good.

In contrast with most of the literature on credence, experience, or search goods, this chapter abstracts from sellers' incentives to provide the right amount of quality in the service, repair, or product offered.[2] There is no asymmetric information or search cost involved in the model. Consumers and producers know the probability of successful match at the two stores. Their technology is taken as a given. The chapter also abstracts from the possibility of warranties for the low quality good. This assumption can be justified as "quality may be impossible or very costly to measure for a court ... [or] enforcement costs [are] incommensurate with the issue" (Tirole (1988), p. 106).

The remainder of the chapter proceeds as follows. Section 4.2 offers the model. The demand analysis follows in Section 4.3, while equilibrium is characterized in Section 4.4. Section 4.5 provides some welfare considerations. Section 4.6 concludes. Finally, Section 4.7 contains all proofs of the lemmas.

4.2 The Model

Consider a linear market of length one. All consumers are located uniformly along this interval and own a good needing a repair. All consumers have a common (reservation) value r for getting the good fixed, and minimize their

[2]Wolinsky (1993), Emons (1994), and Taylor (1995) analyse features of markets diagnoses and treatments. The seminal chapter on experience goods is Nelson (1970). Tirole (1988) offers an overview of models with experience and search goods.

repair expenditures. They incur a linear transportation cost t per unit of length. The density of consumers is normalized to one. There are two sellers. The first seller (the non-expert) is located at the left extreme of the interval ($x = 0$) and sells at price q. He repairs successfully with probability $0 \leq \gamma \leq 1$, and his marginal cost of production is normalized to zero. The repair technology is characterized by perfect correlation between two or more visits at the non-expert's store for every consumer. That is, if the non-expert fails to repair a consumer's good, a second repair at his store yields failure with probability one. The other seller (the expert) is located at the other extreme of the interval ($x = 1$) and always repairs successfully at price p. The expert has a constant marginal production cost of $c \geq 0$.[3] Every consumer has to choose between two possible actions. The first action is to visit the expert's store immediately. With this action, the consumer at location z, obtains a surplus of $r - p - t(1 - z)$. The other action is to go to the non-expert first. A successful repair at this store yields a consumer at location z a surplus of $r - q - tz$. If the repair was not successful, another visit at the non-expert's store is useless; the characteristics of the repair technology imply zero probability of success. Therefore, the consumer re-enters the market and decides whether to visit the expert's store or not. Only if he visits the expert's store, the consumer pays the additional amount of $p + t(1 - z)$.[4] His ex ante expected utility, by consequence, amounts to

$$r - q - tz - (1 - \gamma)(p + t(1 - z)).$$

Accordingly, the consumer located at y is indifferent between these two actions if

$$q + ty + (1 - \gamma)(p + t(1 - y)) = p + t(1 - y),$$

where $y \in [0, 1]$ equals

$$y = \frac{(\gamma(p + t) - q)}{(1 + \gamma)t}. \tag{1}$$

[3]The value of c can be interpreted as the difference between the expert's and the non-expert's marginal costs.

[4]We will assume r to be large enough, so that the option not to visit the expert disappears.

To complete the set-up of the model, the expert cannot distinguish buyers once they enter his store: buyers having an unsuccessful repair at the non-expert and entering the expert's store are identical to consumers following the first action. This means, the expert cannot make his price contingent on such information.

The next section provides a complete characterization of both firms' demand function.

4.3 Demand Analysis

For a fixed value of p, say $\overline{p}$, the non-expert's (contingent) demand curve is defined as

$$D_n(\overline{p}, q) \equiv \begin{cases} 0 & \text{if } q \geq \gamma(\overline{p}+t) \\ y & \text{if } \gamma(\overline{p}+t) \geq q \geq \gamma\overline{p} - t \\ 1 & \text{if } \gamma\overline{p} - t \geq q. \end{cases} \tag{2}$$

The non-expert's demand is continuous and piecewise linear. Three possible price regions have to be distinguished. In the first, the non-expert's demand equals zero if the consumer located at 0 finds it more profitable to visit the expert first. In the second, a positive fraction y of the consumers finds it profitable to visit the non-expert first at a lower price q. Finally, when the price q is sufficiently low, the non-expert's demand equals one since all consumers find it profitable to visit him first.

Similarly, for a fixed value q, say $\overline{q}$, the expert's (contingent) demand curve is defined as

$$D_e(p, \overline{q}) \equiv \begin{cases} 0 & \text{if } p \geq r \\ (1-\gamma)(r-p)/t & \text{if } r \geq p \geq r - t \\ 1-\gamma & \text{if } r - t \geq p \geq (\overline{q}+t)/\gamma \\ 1-\gamma y & \text{if } (\overline{q}+t)/\gamma \geq p \geq (\overline{q}/\gamma) - t \\ 1 & \text{if } (\overline{q}/\gamma) - t \geq p. \end{cases} \tag{3}$$

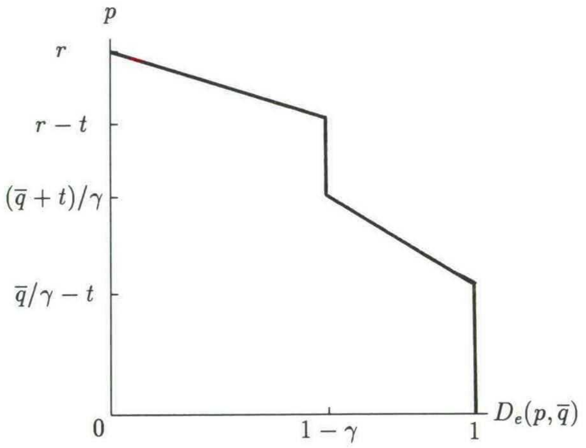

Figure 1: The expert's inverse demand curve.

The expert's demand is continuous and piecewise linear. It consists of five price regions. In the first constellation of this demand schedule no consumer visits the expert's store. In the second one, all consumers first visit the non-expert. More distant consumers, however, prefer not to visit the expert if failure at the non-expert occurred. For example, the consumer at location 0 will never buy at the expert's store; doing so would at most yield her negative utility. In the third constellation, all consumers first visit the non-expert and, if necessary, buy at the expert. The fourth price constellation of the demand schedule shows that consumers to the left of y first visit the non-expert and, if necessary, the expert. The other consumers immediately go to the expert's store. Notice that the third and fourth price region destroy the concavity in the expert's demand curve. For extremely low prices, as in the last price region, the expert serves the whole market.

Figure 1 illustrates the corresponding price regions. As defined in Eq. (3), it assumes that $r - t \geq (\overline{q} + t)/\gamma$. In words, if the expert charges the price

$p = r - t$, all consumers first visit the non-expert. That is, at $p \geq r - t$ the expert can only attract "failures". It follows from the above demand analysis, that total demand $D_n(p,q) + D_e(p,q)$ in the market varies between 0 and $2 - \gamma$.

A different situation occurs when $(\overline{q} + t)/\gamma > r - t$. If $p = r - t$, some consumers visit the expert directly. In this event, the vertical line of the inverse demand in Figure 2 at $1 - \gamma$ disappears. If $(\overline{q} + t)/\gamma > r - t \geq p$, all failures still visit the expert. If, however, $(\overline{q} + t)/\gamma \geq p > r - t$ some consumers who experienced a bad match at the non-expert do not visit the expert anymore. In particular, those consumers sufficiently close to zero incur a negative utility from doing so. Since this chapter aims at discussing when it is optimal for all consumers to first visit the non-expert before the expert, we will only consider the situation where $(\overline{q} + t)/\gamma \leq r - t$. In the next section, Assumptions 1 and 2 make clear that this implies a restriction on the parameters.

4.4 Equilibrium Analysis

From Eq. (2) the non-expert's profit function equals

$$\pi_n(q, \overline{p}) = q D_n(\overline{p}, q) \tag{4}$$

and is continuous and concave in the non-expert's price q.

Lemma 1: *The non-expert's best-response function equals* $R_n(p) = \max[0.5\gamma(p + t), \gamma p - t]$.

Lemma 1 implies that if $p < \hat{p} \equiv t(2+\gamma)/\gamma$, the non-expert does not serve the whole market. If, however, $p \geq \hat{p}$, it is optimal for the non-expert to serve all consumers. It follows from Lemma 1 that the second part of Eq. (2) of the non-expert's demand is the only relevant one since he will never set any $q < \gamma p - t$ or $\gamma(p + t) < q$.

Assumption 1: $r \geq 2t + c$.

Assumption 2: $r \geq 2t(1+\gamma)/\gamma$.

Assumption 1 guarantees that the expert would serve the whole market if he were in a monopoly position. The second assumption implies that if the expert charges the monopoly price $p = r - t$, the non-expert finds it optimal to serve the whole market. In other words, if the expert charges the monopoly price all consumers find it optimal to first visit the non-expert. If $2t/c \geq \gamma$, it is sufficient if the consumers' reservation value satisfies Assumption 2. Otherwise, Assumption 1 is sufficient. At price $p = r - t$, all consumers who had an unsuccessful match at the non-expert's store find it also optimal to visit the expert. Therefore, at the monopoly price the expert only serves the failures. Lemmas 2 and 3 show the implications of Assumption 2 in more detail.

Lemma 2: *If the expert charges $p^* = r - t$ in equilibrium, then the indifferent consumer's location is $y^* = 1$.*

Lemma 3: *If in equilibrium $y^* = 1$, then $p^* = r - t$.*

Lemmas 2 and 3 state that the expert charges the monopoly price if and only if the non-expert serves the whole market.

Lemma 4: *In any equilibrium the expert will never charge $p^* > r - t$ or $p^* < q^*/\gamma - t$.*

Lemma 4 implies that the expert will never charge a price exceeding some consumer's willingness to pay. In addition, the indifferent consumer will never be to the left of the non-expert's location. From Eq. (3) the expert's profit function equals

$$\pi_e(p, \overline{q}) = (p - c)D_e(p, \overline{q}). \tag{5}$$

Equation (5) is continuous but non-concave in the expert's price p. From Lemma 4, the expert's price in any equilibrium is between $q/\gamma - t$ and $r - t$. That is, only the third and fourth price region in Eq. (3) can occur in equilibrium. Each part has exactly one maximum. A first possible maximum is in the fourth price region. In other words, some consumers go first to the non-expert while others go directly to the expert. In this price region the expert's profit function is quadratic and equals

$$\pi_e(p, \overline{q}) = (p - c)(1 - \gamma y). \tag{6}$$

The first-order condition for the r.h.s. of Eq. (6) is defined as

$$\tilde{p}(q) \equiv p = \frac{t + \gamma(q + t) - \gamma^2(t - c)}{2\gamma^2}. \tag{7}$$

The price $\tilde{p}(q)$ is increasing in the non-expert's price q. It is, however, decreasing in the probability of success of the non-expert. The first-order condition as defined by Eq. (7) only holds if $q/\gamma - t \leq \tilde{p}(q) \leq (q + t)/\gamma$. Equivalently, this first-order condition applies if $q_l \leq q \leq q_h$ where

$$q_l \equiv \gamma(c - t) - t(1 - 1/\gamma), \tag{8}$$

$$q_h \equiv \gamma c + t(1 + \gamma + (1/\gamma)). \tag{9}$$

Two other cases, therefore, need to be distinguished. First, if $q < q_l$ the expert's optimal price becomes $p = (q + t)/\gamma$ in this part of the profit function. Second, if $q_h < q$, the expert optimally charges a price $p = q/\gamma - t$.

The second possible maximum arises when the expert only attracts "failures". That is, all consumers first go to the non-expert and, by consequence, the expert only serves consumers who had an unsuccessful match at the non-expert. In this event, the expert's demand is given by the third price region in Eq. (3). If $p \leq r - t$, there is no effect on the expert's demand. The expert's profit function increases linear in its price p since demand is constant and equal to $1 - \gamma$. Lemma 3 implies that setting $p > r - t$ is not optimal. This part of the profit function reaches its maximum at $p = r - t$. Therefore, if the non-expert serves the whole market, the expert's profit equals

$$\pi_e(r-t,\overline{q}) = (r-t-c)(1-\gamma). \tag{10}$$

The expert, therefore, compares the maximum of Eq. (6) with Eq. (10) and chooses the highest one. Figures $2a-c$ illustrate the three possible curvatures of the expert's profit function. Figure $2a$ shows the case where the first-order condition applies. For low enough r, the expert's optimal price equals $\tilde{p}(q)$. If, however, the reservation value r is high enough, the expert optimally charges the monopoly price of $r-t$ (dashed part). Figure $2b$ illustrates the case where $q \leq q_l$. The profit function shows a positive slope everywhere. From the continuity of the function, the monopoly price $r-t$ is the unique optimal price. Finally, Figure $2c$ shows the case where $q_h < q$. For low values of the consumers' reservation value, the expert charges $p = q/\gamma - t$. For high enough r, the expert's optimal price equals the monopoly price (dashed part).

All this leads to the following lemma about the expert's best response:

Lemma 5: *The expert's best response function is either* $R_e(q) = r-t$ *or* $R_e(q) = \max[\tilde{p}(q), q/\gamma - t]$.

In essence, Lemma 5 states that the expert's choice is whether to serve *only* failures or not. If he serves only failures, there is no need to compete fiercely for consumers: an increase in the price p does not affect his demand. Hence, by charging the monopoly price $p = r-t$, the expert adopts a "timid-pricing" strategy. The other choice for the expert is to charge a price as to make some consumers visit him directly. If the non-expert's price is high, consumers are more willing to visit the expert's store directly. In this case, by adopting an "agressive-pricing" strategy, the expert can increase his demand substantially.

Define the function $\hat{q}(\cdot)$ by

$$\hat{q}(\gamma) \equiv 2\sqrt{t(1-\gamma^2)(r-t-c)} + \gamma(c+t) - t(1+1/\gamma). \tag{11}$$

The right hand side of Eq. (11) is the sum of three terms. The first term is

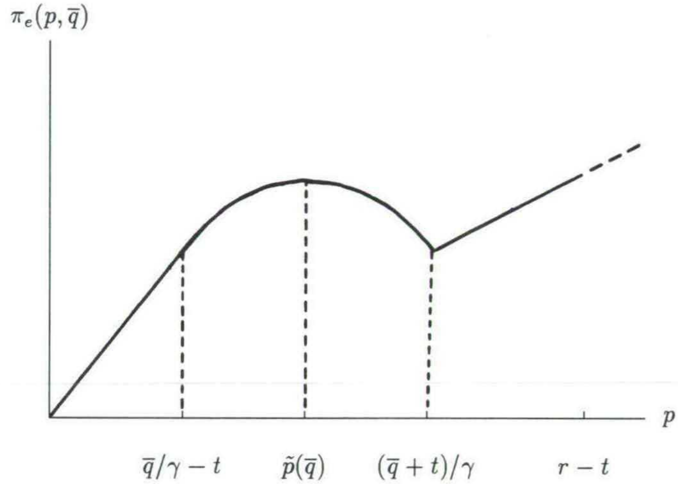

Figure 2a: The expert's profit function for $q_l \leq q \leq q_h$.

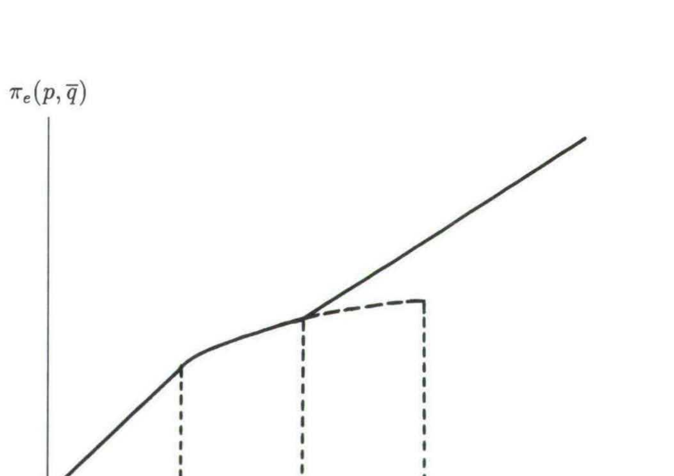

Figure 2b: The expert's profit function for $q < q_l$.

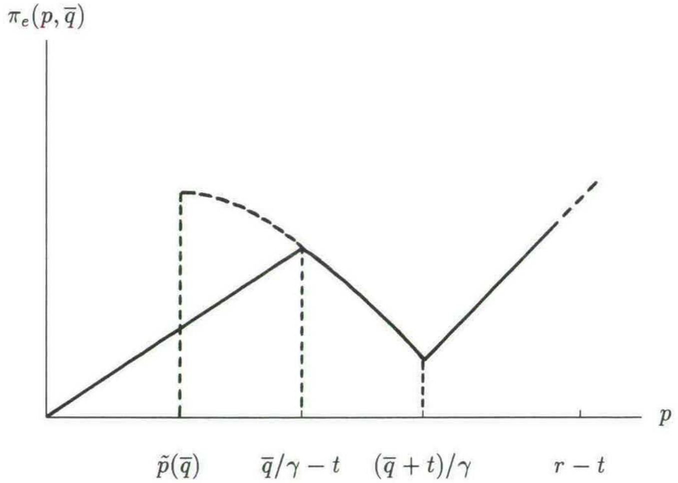

Figure 2c: The expert's profit function for $q_h < q$.

positive and decreasing since $\gamma \leq 1$, and $r - t - c > 0$; the other two terms are increasing in γ. From Assumption 2, however, the Eq. (11) is only defined for $\gamma \in [\tilde{\gamma}, 1]$ where $\tilde{\gamma} = 2t/(r-2t)$. Note that $\hat{q}(1) = c - t$. Finally, define by $\dot{q} \equiv \gamma((r-t)(1-\gamma)+t)$.

Lemma 6: *The expert's best response function is*

$$p = \begin{cases} r-t & \text{if } 0 \leq q \leq q_l \\ r-t & \text{if } q_l \leq q \leq \min(\hat{q}(\gamma), q_h) \\ \tilde{p}(q) & \text{if } \max(q_l, \hat{q}(\gamma)) \leq q \leq q_h \\ r-t & \text{if } q_h \leq q \leq \dot{q} \\ q/\gamma - t & \text{if } \max(q_h, \dot{q}) \leq q. \end{cases} \tag{12}$$

Lemma 7: *It can never occur in equilibrium that (i) $q^* < q_l$; (ii) $p^* = r - t$ if $q_h \leq q^* \leq \dot{q}$; or (iii) $p^* = q^*/\gamma - t$ if $\max(q_h, \dot{q}) \leq q^*$.*

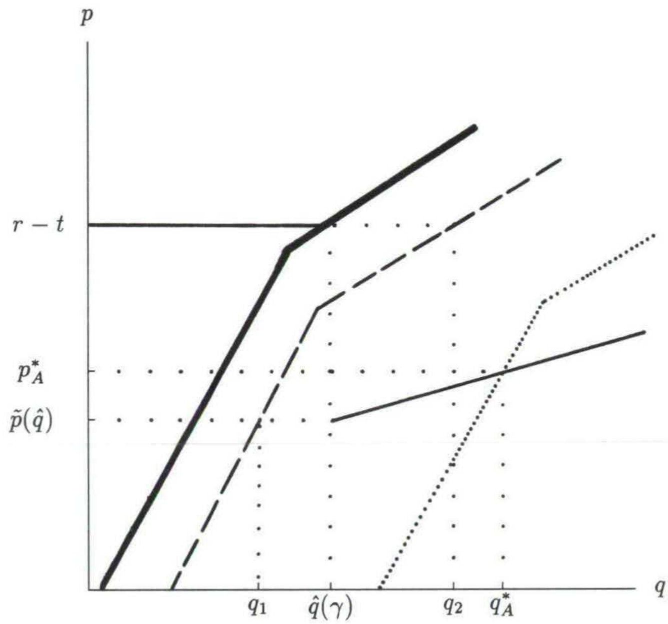

Figure 3: The best response functions.

Lemma 7 implies that Figure 2a applies in any equilibrium since the non-expert's price q^* is between $q_l \leq q^* \leq q_h$. Figure 3 illustrates the parts of the best response functions that are relevant for an analysis of the equilibrium. The expert's best response function starts at $p = r - t$ and remains horizontal for all prices to the left of $\hat{q}(\gamma)$. It has a downward jump at $\hat{q}(\gamma)$ and increases in a linear way for all $\hat{q}(\gamma) \leq q \leq q_h$. The non-expert's best response is increasing, continuous, and shows a kink at $p = \hat{p}$.

Lemma 8: *There is no equilibrium with $p^* = r - t$ and (i) $q^* = 0.5\gamma r$ or (ii) $q^* < \hat{q}(\gamma)$.*

Part *(i)* implies that it is never optimal for the non-expert not to serve the whole market when the expert charges the monopoly price. This is a direct consequence of Assumption 2. Part *(ii)* states that, in equilibrium, the non-expert's best response of Figure 3 is never strictly lower than $\hat{q}(\gamma)$. As a matter of fact, since the expert only serves failures when charging his monopoly price $p^* = r - t$, the non-expert does not loose any demand when increasing his price until $q^* = \hat{q}(\gamma)$.

Lemma 9: *If there is an equilibrium with* $q^* = 0.5\gamma(p^* + t)$ *and* $p^* = \tilde{p}(q^*)$, *then* $q^* \geq \hat{q}(\gamma)$, $p^* \leq (q^* + t)/\gamma$, *and* $p^* \leq \hat{p}$.

Proposition 1: *There is a* $0 < \gamma_A^* \leq 1$ *such that some consumers go directly to the expert if the probability of success* γ *at the non-expert is at least* γ_A^*. *In this "agressive-pricing" equilibrium* (p_A^*, q_A^*) *it holds that* $\hat{q}(\gamma) \leq q_A^* \leq q_h$ *and*

$$p_A^* = \frac{\gamma^2(2c - t) + 2\gamma t + 2t}{3\gamma^2}, \qquad q_A^* = \frac{\gamma^2(c + t) + (1 + \gamma)t}{3\gamma}.$$

The non-expert's market share in this "agressive-pricing" equilibrium equals

$$0 \leq y_A^* = \frac{c\gamma^2 + (1 + \gamma + \gamma^2)t}{3\gamma t(1 + \gamma)} \leq 1. \tag{13}$$

Proof: From Lemma 7, a necessary and sufficient condition for $p_A^* = \tilde{p}(q_A^*)$ to be the expert's best response is that $\hat{q}(\gamma) \leq q_A^*$. Since $p_A^* \leq (q_A^* + t)/\gamma$, this is equivalent to $q_A^* \leq q_h$. Solving Eq. (7) and $R_n(p) = 0.5\gamma(p + t)$ yields the equilibrium prices. The non-expert's market share y_A^* follows from substituting p_A^* and q_A^* into Eq. (1). In any "agressive-pricing" equilibrium $0 \leq y_A^* \leq 1$. Let $0 \leq \underline{\gamma}_A \leq 1$ solve $y_A^* = 1$, it follows from Eq. (13) that $\gamma \geq \underline{\gamma}_A$ in any "agressive-pricing" equilibrium. Finally, for all $\gamma \geq \underline{\gamma}_A$ we have that γ_A^* is the unique solution to $\hat{q}(\gamma) - q_A^* = 0$. From Lemmas 8 and 9, we know that $q_A^* \geq \hat{q}(\gamma_A^*)$, which is satisfied if $\gamma \geq \gamma_A^*$. □

The dotted line in Figure 3 illustrates the non-expert's best response function in the "agressive-pricing" equilibrium. Some consumers prefer to directly visit the expert's store. Not surprisingly, $p_A^* \geq q_A^*$. The expert charges at least as high a price as the non-expert. The expert's profits, however, exceed the non-expert's provided c is not too large. Of course, for $c = 0$ and $\gamma = 1$, their prices and profits coincide. Both prices increase with the expert's marginal cost c and the rate of tranportation cost t. More consumers directly visit the expert when the cost of transportation increases, while the opposite happens when the expert's cost increases. Note that when t approaches zero, Eq. (13) does no longer satisfy the boundaries.

Figures 4*a*-*c* illustrate with some representative numerical examples the relevant ranges of γ for which an "agressive-pricing" equilibrium exists. The horizontal axis depicts the values for γ. The vertical axis shows the non-expert's price q_A^* from Proposition 1, $\hat{q}(\gamma)$ as defined in Eq. (11), and the non-expert's price $\gamma(r-t)-t$ when the expert charges his monopoly price. They are indicated by [1], [2], and [3], respectively. Since any equilibrium must satisfy Assumption 2, a necessary condition is that $\gamma \geq \tilde{\gamma}$. In addition, from Lemma 7 we know that $q_l \leq \gamma(r-t)-t$. Equivalently, $\gamma \geq \gamma_l \equiv \sqrt{t/(r-c)}$. Finally, $0 \leq y_A^* \leq 1$ in any "agressive-pricing" equilibrium. This is equivalent to $\underline{\gamma}_A \leq \gamma$. Therefore, the horizontal axis is only relevant for values of $\gamma \geq \max(\tilde{\gamma}, \gamma_l, \underline{\gamma}_A)$. Figures 4*a*-*c* show there is an "agressive-pricing" equilibrium if $\hat{q}(\gamma) \leq q_A^*$. That is, for all $\gamma \geq \gamma_A^*$. As an example, take Figure 4*a*. The probability of success at the non-expert is at least $\gamma_A^* \approx 0.934$ in any "agressive-pricing" equilibrium. Thus, the probability of a successful match of the non-expert should be high enough. The intuition is that a relatively successful non-expert is a close substitute for the expert. In other words, the expert's residual demand for "failures" becomes very small. The attractiveness for the expert of charging the monopoly price, by consequence, disappears. Figures $4b - c$ are interpreted in a similar way.

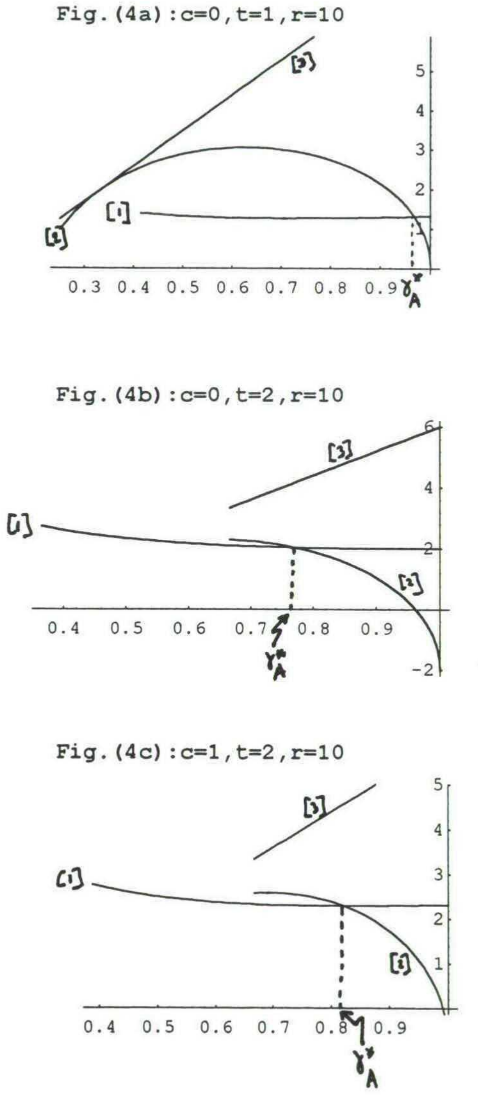

Figure 4: The relevant ranges of γ in each equilibrium.

The entries in Table 1 are the critical values for γ_A^* given parametric values of r, c, and t. In other words, the "agressive-pricing" equilibrium holds for all $\gamma \geq \gamma_A^*$. Table 1 illustrates that an increase in the expert's cost c positively affects the value of γ_A^*. The intuition is the following: an increase in the expert's cost structure, undoubtedly, decreases his profits from serving only "failures". This practice, however, avoids him being exposed to a weakened competitive position because of this higher cost structure. Therefore, only a higher probability of the non-expert's success can make it more profitable for the expert to directly compete with the non-expert. This explains the positive relationship between c and γ_A^*. An increase in the cost of transportation t, however, makes it less attractive for both sellers to serve the whole market and, therefore, negatively affects γ_A^*.

	$t = 1$	$t = 2$
$c = 0$	0.934	0.770
$c = 1$	0.967	0.820

Table 1: Critical values for γ_A^* (for $r = 10$).

Proposition 2: *There is no equilibrium in pure strategies if the probability of success is smaller than* γ_A^*. *That is, if* $q_A^* < \hat{q}(\gamma) < \gamma(r-t) - t$.

Proof: Suppose there is an "agressive-pricing" equilibrium in pure strategies such that $\gamma < \gamma_A^*$, or equivalently $q_A^* < \hat{q}(\gamma)$. From Lemma 6, it follows that the expert's best response is to charge $r - t$. From Lemma 2, however, the non-expert's best reply then equals $\gamma(r-t) - t$. But $\hat{q}(\gamma) < \gamma(r-t) - t$. A contradiction. $\square$

Figures 4*a*-*c* illustrate Proposition 2: for $\max(\tilde{\gamma}, \gamma_l, \underline{\gamma}_A) \leq \gamma \leq \gamma_A^*$ there exists no equilibrium in pure strategies. In words, for low enough probabilities of successful repair an equilibrium in pure strategies fails to exist. In addition, when the cost of transportation t decreases, the critical value γ_A^* increases. That is, a lower degree of horizontal differentiation increases the range of γ-values for which an equilibrium in pure strategies fails to exist. The non-existence of an equilibrium in pure strategies results from the non-concavity of the expert's profit function. The expert is indifferent between charging p_A^* and his monopoly price $r-t$ only if the non-expert sets the price $\hat{q}(\gamma)$. The non-expert, however, optimally charges another price in response to the expert's prices. The dashed best-response function for the non-expert in Figure 3 illustrates Proposition 2. As the dashed line passes through the discontinuous part of the expert's best response, no equilibrium in pure strategies exists.[5] Proposition 3, however, shows that for these values of γ, there exists a unique equilibrium in mixed strategies.

Proposition 3: *If $q_A^* < \hat{q}(\gamma) \leq \gamma(r-t)-t$, there exists a unique "mixed-pricing" equilibrium (p_M^*, q_M^*, α^*). In this equilibrium the expert charges his monopoly price $p = r-t$ with probability α^*. In this event, all consumers first visit the non-expert. With the remaining probability $1-\alpha^*$, the expert charges $p_M^* = \tilde{p}(q_M^*)$. The non-expert charges $q_M^* = \hat{q}(\gamma)$ with probability one.*

Proof : If the non-expert charges $\hat{q}(\gamma)$, we know that the expert is indifferent between charging $r-t$ or $\tilde{p}(\hat{q})$. Since his profits are exactly identical, the expert is as well indifferent by charging these two prices with any probability α and $1-\alpha$, respectively. From the non-expert's best response, the non-expert's profit is increasing in his price for all $q \leq q_1$ (see Figure 3), irrespective the price p charged by the expert. For all prices $q_1 \leq q \leq q_2$ (see Figure 3), the non-expert's profit is decreasing in its price when $p = \tilde{p}(\hat{q})$ but increasing when $p = r-t$. For all $q_2 \leq q$, the non-expert's profit is decreasing in p. Thus, for all prices $q_1 \leq q \leq q_2$, there exists a unique value α^* such that the non-expert's marginal profit equals zero. Since $q_1 \leq \hat{q}(\gamma) \leq q_2$, this also holds for $\hat{q}(\gamma)$. Uniqueness results from the non-expert's concave profit function and that the expert only wants to randomize when the non-expert charges $\hat{q}(\gamma)$. Since $\hat{q}(\gamma) \leq \gamma(r-t)-t$, it follows from Assumption 2 that all consumers first visit the non-expert when the expert charges his monopoly price. □

[5] Krishna's (1989) model has identical features in the context of voluntary export restrictions (see also Krugman (1989)).

Harsanyi (1973) provides a rationale for the above "mixed-pricing" equilibrium by constructing a related "disturbed" game. In this disturbed game, the expert's cost structure c is subject to some exogenous random shock, the value of which the expert knows with certainty. In contrast, the non-expert faces uncertainty about its exact value. In addition, suppose the non-expert beliefs that the expert's costs are uniformly distributed around c. Then, in the limit, as these pay-off related disturbances vanish, the non-expert's beliefs approach the mixed strategy equilibrium. In other words, Harsanyi interprets the probabilities with which the expert "randomizes" in the mixed strategy context, as the non-expert's "rate of ignorance" about the expert's cost structure. In this sense, the expert's "randomizing" behavior gets purified and, therefore, becomes completely deterministic.

As a limiting case of Proposition 3, there is a "timid-pricing" equilibrium (p_T^*, q_T^*) when $\alpha \to 1$. In this equilibrium $p_T^* = r - t$ and $q_T^* = \gamma(r-t) - t$ if $0 \leq q_T^* = \hat{q}(\gamma)$. From Eq. (12) in Lemma 6, the expert's best response, indeed, equals $p_T^* = r - t$ if $0 \leq q_T^* \leq \hat{q}(\gamma)$. From Lemma 2, the non-expert's best response is $q_T^* = \gamma(r-t) - t$ if $p_T^* = r - t$. The dark line of the non-expert's best response in Figure 3 illustrates this limiting case. In this limiting case, the indifferent consumer is located at $y_T^* = 1$. That is, all consumers first visit the non-expert and the expert only serves the failures. Both firms adopt a "timid-pricing" strategy: the non-expert can charge a very high price since the expert charges his monopoly price. The expert's profit equals $(r-t-c)(1-\gamma)$ and the non-expert's profit is $\gamma(r-t) - t$.

4.5 Welfare

This section compares the "agressive-pricing" equilibrium with the social optimum. The social planner chooses the indifferent consumer $y = y_W^*$ such as to minimize total costs C:

$$\min_{y_W^*} \int_0^{y_W^*} ty\,dy + \int_{y_W^*}^1 t(1-y)dy + \int_0^{y_W^*} (1-\gamma)t(1-y)dy + (1-\gamma y_W^*)c. \quad (14)$$

The first term in Eq. (14) is the total transportation costs of all consumers going first to the non-expert. The second term is interpreted similarly, but for all consumers going directly to the expert. The third term represents the transportation costs of all consumers who, because of failure at the non-expert, visit the expert. Finally, the last term shows the expert's total costs.

Solving Eq. (14) for y_W^* yields

$$y_W^* = \frac{\gamma(t+c)}{(1+\gamma)t}. \tag{15}$$

In words, the indifferent consumer's location becomes closer to the expert's location if the probability of a successful repair at the non-expert increases ($\partial y_W^*/\partial\gamma > 0$). Also, an increase in the expert's marginal cost augments the fraction of consumers that first visits the non-expert ($\partial y_W^*/\partial c > 0$). Finally, an increase in the cost of transportation decreases the proportion of consumers going to the non-expert first ($\partial y^*/\partial t < 0$). The indifferent consumer is in the interior if $\gamma \leq t/c$. Substituting this into Eq. (14), one arrives at an optimal social cost

$$\tilde{C} = \frac{\gamma^2(t+c)^2}{2(1+\gamma)t} + 0.5t - \frac{\gamma^2(t+c)}{1+\gamma} + (1 - \frac{\gamma^2(t+c)}{(1+\gamma)t})c.$$

The total surplus in the first best solution is then simply $r - \tilde{C}$. If the social planner can control both prices, the first best solution can easily be achieved: each pair of prices resulting in the indifferent consumer located at y_W^* is optimal. Suppose the social planner can only control the expert's price.[6] Then, the first best solution can still be achieved. This can readily be seen from Eqs. (1) and (15), where $y = y_W^*$ if $q = \gamma(p - c)$. Since the non-expert's best response is continuous, there exists a unique intersection. Following Meurer and Stahl (1994), this is the constrained efficient outcome. By contrast, if the social planner can only control the non-expert's price, the first best solution is not

[6]This may be of interest when only the expert has an official licence for repairing and the non-expert illegally offers repair-services.

necessarily obtained.[7] If $p = q/\gamma + c$ passes through the discontinuous part of the expert's best response, either too many or too few consumers directly visit the non-expert.

Before stating the next proposition, define

$$\gamma_W^* \equiv \frac{t + \sqrt{t^2 + 8t(c+t)}}{4(c+t)}. \tag{16}$$

The right hand side of Eq. (16) is increasing in the rate of transportation cost t; in addition, it approaches zero when t vanishes. It is decreasing in the expert's marginal cost c and approaches one when c tends to zero.

Proposition 4: *A socially efficient proportion of consumers first visits the non-expert in the "agressive-pricing" equilibrium only when $\gamma = \gamma_W^*$ and $\gamma_A^* \leq \gamma_W^*$. If $\gamma_A^* \leq \gamma < \gamma_W^*$, too few consumers first visit the expert from an efficiency point of view. If $\max(\gamma_A^*, \gamma_W^*) \leq \gamma$, too many consumers first visit the expert.*

Proof: The proportion of consumers in the "agressive-pricing" equilibrium of Eq. (13) and in the socially efficient outcome of Eq. (15) depends on γ. For positive values of γ, the r.h.s. of these two equations are identical only when $\gamma = \gamma_W^*$. The socially right amount of consumers first visit the non-expert if and only if $y_A^* = y_W^*$, or equivalently when $\gamma = \gamma_W^*$. Of course, in any "agressive-pricing" equilibrium $\gamma \geq \gamma_A^*$. As a result, too few consumers first visit the expert when $y_W^* < y_A^*$, that is for $\gamma_A^* \leq \gamma < \gamma_W^*$. Similarly, too many consumers first visit the expert when $y_A^* \leq y_W^*$, that is for $\max(\gamma_A^*, \gamma_W^*) \leq \gamma$. □

The entries in Table 2 are the γ-values for which the market outcome coincides with the socially efficient outcome given the parametric values of r, c, and t. Table 2 shows that in the numerical examples where $c = 0$, the probability of success at which the market outcome coincides with the socially efficient outcome is $\gamma_W^* = 1$. By consequence, a comparison with Table 1 makes clear that $\gamma_A^* \leq 1$. That is, when there are no cost differences, not enough con-

[7]This may be of interest when the expert has his location outside the social planner's area of control; e.g. abroad.

sumers directly visit the expert in any "agressive-pricing" equilibrium from an efficiency point of view. In contrast, when $c = 1$, a comparison of Tables 1 and 2 illustrates that $\max(\gamma_W^*, \gamma_A^*) = \gamma_A^* \leq \gamma$. In words, in the "agressive-pricing" equilibrium with a cost difference, too many consumers first visit the expert. All consumers between y_W^* and y_A^* should, from an efficiency point of view, first visit the non-expert: the cost disadvantage results in the expert charging too agressively a price.

	$t = 1$	$t = 2$
$c = 0$	1.000	1.000
$c = 1$	0.640	0.767

Table 2: Market outcome is efficient for $\gamma = \gamma_W^*$ (for $r = 10$).

4.6 Concluding Remarks

This chapter has characterized price competition between an expert and a non-expert. In contrast with the expert, the non-expert's repair technology is not always successful. In a location framework, consumers require a successful repair and seek to minimize their expected expenditures. In the event of an unsuccessful match at the non-expert, the consumer re-enters the market and visits the expert. This simple framework offers the following insights: when the non-expert's repair technology is sufficiently successful, both sellers charge a low and deterministic price. Indeed, the non-expert's low number of failures does not make it attractive for the expert to charge the monopoly price. By doing this, he would only serve those consumers who had an unsuccessful match at the non-expert. In this equilibrium, both sellers charge a deterministic price and some consumers first visit the expert. When the non-expert's repair technology is relatively unsuccessful, the higher number of failures increases the profitability of the expert's residual demand. In equilibrium, the expert randomizes between the monopoly price and a low price. The non-expert, however, charges a deterministic price. If the expert charges his monopoly price, all consumers first visit the non-expert. Finally, a welfare analysis shows that the market outcome in pure strategies results in too few consumers directly visiting the expert when there are no cost differences. In contrast, too many consumers directly visit the expert when there are cost differences.

The following modification to the simple model deserves a short discussion. Suppose the expert considers to price discriminate between the consumers who first visited the non-expert's store (the failures) and those who directly visit his store. Two scenarios are considered. In the first scenario, only failures can prove they first visited the non-expert. These failures should be charged the highest price: the non-expert's repairing technology is such that failures can only go to the expert's store for successful repair. In other words, the expert has a monopoly position with respect to the failures. The failures, certainly, must be given an incentive (a discount) to reveal themselves. Offering a discount to the failures, however, increases the number of consumers first visiting the non-expert. Both the discount and its effect on the indifferent consumer decrease the expert's profit. Therefore, in this scenario it is not optimal for the expert to price discriminate. In the second scenario, the failures cannot hide having visited the non-expert. Hence, the expert could charge these consumers a higher price. Clearly, more consumers will prefer to directly visit the expert. This moves the position of the indifferent consumer to the left (the demand effect). The non-expert, however, will reduce his price (the strategic effect). A priori, it is not clear whether the expert optimally should price discriminate.

The strategic decision whether to become an expert or a non-expert is an important issue. Likewise, the probability of successful repair could be endogenized. These, however, seriously affect the complexity of the model.

4.7 Appendix

Proof of Lemma 1: Since Eq. (4) is concave in q, the non-expert's best response is $q = 0.5\gamma(p+t)$ for any $y \in [0,1]$. From Eq. (2), however, a necessary condition is that $\gamma(p+t) \geq 0.5\gamma(p+t) \geq \gamma p - t$. The first inequality is always satisfied. If the second is not satisfied, the non-expert's demand equals 1. Accordingly, the best response is $\gamma p - t$. □

Proof of Lemma 2: Suppose $y^* < 1$ and the non-expert charges q^* in equilibrium. Then Eq. (1) implies $(\gamma r - q^*) < (1+\gamma)t$. After rearranging and, from Lemma 1, substituting $q^* = 0.5\gamma r$, one has $r < (2t(1+\gamma)/\gamma)$, contradicting Assumption 2. Suppose $y^* > 1$. This, however, cannot occur in equilibrium, since the non-expert can increase his price without affecting demand until $q^* = \gamma(r-t) - t$. Substitution yields the desired result. This proves Lemma 2. □

Proof of Lemma 3: From Eq. (1), $y^* = 1$ implies $\gamma(p^* + t) - q^* = (1+\gamma)t$, or equivalently, $\gamma p^* - t = q^*$. From the non-expert's best response function (see Lemma 1), it follows that $p^* \geq \hat{p}$. The expert's demand equals $1 - \gamma$ if $y^* = 1$. From Assumption 1, it is optimal for the expert to serve the whole market if he were in a monopoly position. Assumption 2 guarantees that $p^* = r - t \geq \hat{p}$. □

Proof of Lemma 4: Suppose the expert charges $p^* > r - t$. From Eq. (3), his profit equals $(p^* - c)(1-\gamma)(r - p^*)/t$. For all $p \geq r - t$, marginal profit is non-positive since $r \geq 2t + c$ by Assumption 1. Suppose the expert charges $p^* < q^*/\gamma - t$. This is equivalent with $y < 0$. As long as $y \leq 0$, the expert can charge a price $p \geq p^*$ while his demand remains at 1. Therefore, $r - t \geq p^* \geq q/\gamma - t$. □

Proof of Lemma 5: Define

$$F(p,q) \equiv (p-c)[1-\gamma\frac{\gamma(p+t)-q}{(1+\gamma)t}].$$

For a given q, the expert can set p such that $y=1$. By Lemma 3, the optimal $p=r-t$. If the expert sets p such that $y<1$, he maximizes $F(p,q)=(p-c)(1-\gamma y)$ subject to the constraint that $y \geq 0$. By the first-order condition for profit maximization this yields $p = \max\ [\tilde{p}(q), q/\gamma - t]$. □

Proof of Lemma 6: By Lemma 5, the expert charges either $p=r-t$ or $p=\max[\tilde{p}(q), q/\gamma-t]$. If $\tilde{p}(q) \geq (q+t)/\gamma$, or equivalently $q \leq q_l$, the indifferent consumer is at 1. This is Figure (2*b*). Then, from Lemma 3, the expert's best response is $p=r-t$. By the envelope theorem, $\max_p F(p,q) = F(\tilde{p}(q),q)$ and is strictly increasing in $q \geq 0$. The equation $F(\tilde{p}(q),q) = (r-t-c)(1-\gamma)$ has the solution $\hat{q}(\gamma)$ over the range where $\mathrm{d}F(\tilde{p}(q),q)/\mathrm{d}q > 0$. By Lemma 4, the expert never charges a price $p > r-t$. Therefore, the expert's best response equals $r-t$ if $q \leq \min(\hat{q}(\gamma), q_h)$. Figure (2*a*) illustrates the case where $q_l \leq q \leq \min(\hat{q}(\gamma), q_h)$. Suppose first that $\min(\hat{q}(\gamma), q_h) = \hat{q}(\gamma)$. Then, if $\max(q_l, \hat{q}(\gamma)) = q_l$, the second part of Eq. (12) does not exist and for any $q_l \leq q \leq q_h$, the expert's best response is $\tilde{p}(q)$. This is illustrated in Figure (2*a*). If, however, $\max(q_l, \hat{q}(\gamma)) = \hat{q}(\gamma)$, the second part of Eq. (12) does exist. The expert's best response is $\tilde{p}(q)$ if $\hat{q}(\gamma) \leq q \leq q_h$. Second, suppose $\min(\hat{q}(\gamma), q_h) = q_h$, then $\max(q_l, \hat{q}(\gamma)) = \hat{q}(\gamma)$ since $q_l < q_h$. It then follows that the third part of Eq. (12) does not exist. If $q > q_h$, the expert charges an optimal price of $p=r-t$ for all $q \leq \dot{q} \equiv \gamma((r-t)(1-\gamma)+t)$. Otherwise, he charges $p = q/\gamma - t$. This is Figure (2*c*). □

Proof of Lemma 7: Suppose *(i)* is part of an equilibrium. This is equivalent to $q^* < \gamma p^* - t$, contradicting Lemma 1. Suppose *(ii)* occurs in equilibrium. Since $q_h \leq q^*$ is equivalent to $p^* \leq q^*/\gamma - t$ we know from Lemma 2 and 3 that if $p^* = r-t$, the non-expert charges $q^* = \gamma(r-t)-t$. Substitution then yields $r-t \leq (\gamma(r-t)-t)/\gamma - t$. A contradiction. Suppose *(iii)* occurs in equilibrium from which $q^* = \gamma(p^*+t)$. From Lemma 1, we know that the non-expert's best response is $\max[0.5\gamma(p^*+t), \gamma p^* - t]$. A contradiction. □

Proof of Lemma 8: If $q^* = 0.5\gamma r$, then from Lemma 1, it must follow that $0.5\gamma r > \gamma(r-t) - t$. Equivalently, $r < 2t(1+\gamma)/\gamma$, contradicting Assumption 2. This proves part *(i)*. Suppose the non-expert charges a price $q^* < \hat{q}(\gamma)$. From Lemma 6, the expert charges $p = r - t$ if $q \leq \hat{q}(\gamma)$. By slightly increasing his price, the non-expert can increase his profit without loosing any demand. Therefore $q^* < \hat{q}(\gamma)$ cannot be part of an equilibrium. This proves part *(ii)*. □

Proof of Lemma 9: Suppose $q^* < \hat{q}(\gamma)$, then from Lemma 6, the expert's best response is to charge $p = r - t$. But then, the non-expert best response equals $q = \gamma(r-t) - t$. From Lemma 7, $p^* > (q^* + t)/\gamma$ can never be an equilibium. Finally, suppose $p^* > \hat{p}$, then $y^* = 1$ from Lemma 1. It follows from Lemmas 2 and 3 that $q^* = \gamma p^* - t$. A contradiction. □

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Chapter 5

Bargaining in Markets with Simultaneous and Sequential Suppliers

5.1 Introduction

This chapter is concerned with two regimes in a market where suppliers 'wait at stand' for customers to arrive. In the first regime suppliers *simultaneously* offer their good or service for sale. Customers may *randomly* select a supplier. In such a 'random-market', trade can take place upon mutual agreement between the trading partners, whatever the supplier's position in the queue. The other regime is based on the so-called 'first-come first-served' or 'first-in first-out' (*FIFO*) principle. In such a *FIFO*-market, suppliers *sequentially* offer their good or service. This second regime has a unique market feature since the suppliers' positions in the queue determine the exact sequence of their trading opportunities. Upon his arrival in the market, a customer's trading partner ranks *in front of* the queue.

We illustrate these two forms of market organization with some examples. The first example is the market where taxis wait at stand. In the random-market, customers can upon arrival choose any taxi at their disposal. In contrast, customers must pick the first taxi in line in the *FIFO*-market. Airports are by far the largest cab stand markets (see Teal and Berglund (1987)). Frankena and Pautler (1984) report that high fares at airport cab stands called for revision in the *FIFO*-system of queuing. The inland waterways transport market for freight is the second example. In some European countries, the loading of barges and cargoes shows some organizational features like in the market where taxis wait at stand. The Rhine inland waterways transport market between The Netherlands and Germany is organized as a random-market: shippers can choose any available barge whatever its position in the queue. The so-called *tour de rôle* system obliges shippers to first deal with the barge in front of the queue. This *FIFO*-system particularly concerns the North-South inland waterways transport market between The Netherlands, Belgium, and France. It affects about 15 per cent of the total inland waterways transport market. Recently, the EU-Commission has claimed that its attempt to realise the full potential of its inland waterways has been hampered by restrictive practices. The Commission has passed judgment on this *tour de rôle* system as anti-competitive behavior. The third example concerns the labor market where unemployed people in some cases are served on a first-come first-served basis. Governmental agencies engaged in matching labor supply and demand often give priority to people with a long duration unemployment history. Finally, in the (regulated) housing market, some (governmental) agencies apply the same kind of mechanism: available housing is offered first to people who appeared as the first on the waiting list.

In each of these *FIFO*-markets, the right to maintain prior service differs to some degree. In the taxi-example, customers can only negotiate with the first available taxi in the line. In the waterways transport market, shippers deal first with the bargeman in front of the queue. Upon disagreement, the shipper may switch to the second barge in the line, and so on. In the event of disagreement, however, the barges are allowed to maintain their position during 60 days. In the Dutch regulated housing market, the person with rank one cannot maintain the first position after having refused two times. The longer the right to keep this first position after disagreement, the better is one's bargaining position.

This chapter will mainly have a market in mind that looks like the taxi-market.

We compare the outcome of the negotiation in both regimes and investigate whether the two regimes can coexist in a market equilibrium. Prices will be determined through bilateral negotiations. The customer and supplier will share the gains from trade according to the symmetric Nash bargaining solution. Of course, each regime will influence the gains from trade in a particular way. The two regimes dealt with in the chapter, indeed, imply different alternatives for one or the other trading partner. Each regime determines the customer's and supplier's 'disagreement point', and hence, each party's bargaining position.[1] In the random-market, the trading partners are involved in a partial bilateral monopoly situation. It gives the supplier a weak bargaining position. The *FIFO*-market, however, generates a bilateral monopoly situation between the trading partners. In consequence, the negotiated outcome in the *FIFO*-market is higher than in the random-market. Suppliers' expected payoff in the *FIFO*-regime, however, is not always preferred to that in the random-regime. In the *FIFO*-market, every supplier has a positive expected current payoff only when ranking first. Otherwise, his current payoff equals zero. By contrast, in the random-market, all suppliers have a positive expected payoff in each period. Since waiting is costly, suppliers in the *FIFO*-market facing a long waiting time may consider to join the random-market, despite the lower negotiated outcome in this market. Thus, consider suppliers making a mutually exclusive choice between a random-market and a *FIFO*-market. When customers cannot choose between these two markets, the market equilibrium always has the property that there are suppliers in *both* markets. The ratio of suppliers in the random-market to the *FIFO*-market becomes infinitely large as the total number of suppliers approaches infinity.

The above examples all have the typical properties of a search market: customers observe prices only at some cost. In the taxi market, cab-riders face high transaction costs in finding the lowest fare. In particular, the market

[1] See Shaked and Sutton (1984) for a non-cooperative approach to bargaining with outside options.

segments of cruising taxis and taxis using stands (at locations such as airports, railway stations, and hotels) seem to impede price competition.[2] The 'monopoly'-paradox of Diamond (1971) predicts that even with negligibly small (but positive) search costs and a large number of sellers, the equilibrium market price equals the monopoly price.[3] Diamond's analysis, however, presumes that sellers set prices and consumers act as price takers. That is, prices are set on a take-it-or-leave-it basis. Bargaining, as another term of trade, provides a way out of Diamond's extreme prediction.[4] Bester (1993, 1994) studies the equilibrium determination of these two pricing rules. This chapter studies how the organization of supply determines the outcome of the negotiation.

The remainder of this chapter proceeds as follows. In Section **5.2**, we present a simple model that permits to compute the negotiated outcome for the 'random' and 'first-in first-out' market organization. Sections **5.3** and **5.4** analyse the outcome for the two market organizations. The stability of the 'first-in first-out' market against the 'random'-market organization is shown in Section **5.5**. Section **5.6** makes some concluding remarks.

5.2 The Model

The number of suppliers equals $N \geq 1$ in each period and all suppliers are identical. Each supplier offers one unit of service. The unit cost of production equals $c \geq 0$. A market is composed of identical customers. In each period, exactly one customer arrives with probability $0 < \delta \leq 1$ in the market. With the remaining probability no customer enters the market. The customer's reservation value equals $r > c$. Each customer buys at most one supplier-service. Communication occurs only during trade and exactly between one supplier and

[2] The largest market segment in the U.S., however, is the radio-dispatched or telephone order market. It accounts for 70% to 80% of the total taxi market. In this market segment, price advertising is much more intensive and offers a reasonable explanation for the difference in degree of competitiveness.

[3] This will be the case in both the random and 'first-in first-out' market.

[4] See Diamond (1989) for an overview.

one customer. Both bargain about the price. If the customer finds the price not attractive enough, he can switch to another supplier. An alternative option is to leave the market, the value of which is normalized to zero.[5] Switching from one of the N suppliers to another or leaving the market takes one unit of time. The customer discounts every unit of time with a factor $0 < \alpha < 1$. Switching, therefore, is costly. Of course, the customer's decision for switching to another supplier depends on the price p_e he expects to pay upon agreement at another supplier. If the supplier finds the price unattractive, he can wait for the next customer or leave the market. The supplier discounts future revenues by a factor $0 < \beta < 1$. Thus waiting for the next customer is a costly action. The customers' and suppliers' price expectations are rational. The analysis focuses on two different regimes of market organization where suppliers wait at stand: the random system and the first-in-first-out (FIFO) queue system. In the first regime, customers make their selection *ad random* since all suppliers look alike. Trade can take place upon agreement between customer and the selected supplier. In the event of disagreement a customer again *randomly* picks a supplier. By contrast, in the *FIFO*-regime a customer must select the first available supplier. Thus, when all suppliers are available, an entering customer has to take the supplier first in line. If the first supplier is not available, an entering customer has to take the second supplier in line, and so on. Disagreement between two trading partners implies that the customer may not switch to a supplier with another position. More precisely, in the event of disagreement the customer has to select again the same supplier in the next period. To summarize: all customers have to select the first available supplier and upon disagreement stick to that same supplier.[6] The organization of supply, therefore, determines

[5]The customer may leave the market and switch to a substitute such as public transit in the case of taxis.

[6]In the queueing literature suppliers can be interpreted as servers. Each regime is described by B/T/n/FCFS/∞/∞. The first characteristic B denotes the nature of the arrival process for customers; in this model the arrival process follows a binomial distribution. The second characteristic T specifies the nature of the service times and follows some distribution. The third characteristic n is the number of parallel servers. In the random-regime this number n coincides with the number N of suppliers, while in the *FIFO*-regime this number n equals one. The fourth characteristic describes the customers' queue discipline. This model assumes

the customer's and supplier's 'disagreement point'. Trade can take place upon agreement between the two parties. Finally, all parties are risk-neutral and maximize their expected payoffs.

As stated above, the number of suppliers in the market is constant. The reason is that we want to focus on the steady state. In other words, a new supplier arrives only if one supplier had an agreement with a customer and left the stand. The number of suppliers, therefore, can be treated as a constant. The assumption of a constant number of suppliers is similar to Rubinstein and Wolinsky (1985). There, agents of opposite types are matched according to some meeting technology and leave the market after reaching an agreement. They assume that the equilibrium flow of departures is exactly equal to the exogenous arrival flow of new agents of both types.

5.3 The 'Random'-market

In the random-regime, a customer has the choice between randomly selecting a supplier S or leaving the market upon arrival at the location where suppliers wait at stand. In case of selecting a supplier S, the customer can find out the price only through bilateral negotiation. In the event of disagreement, the customer can stay in the market and, before a potentially entering new customer arrives, again select *ad random* one of the N suppliers in the next period. In other words, the customer re-enters the market as if he entered for the first time.[7] In this next period, the customer anticipates agreement at price p_e. Therefore, in the event of disagreement his expected discounted payoff from

that customers are served on a first-come first-served (FCFS) basis. The fifth specifies the maximum allowable number of customers in the system. Finally, the sixth characteristic refers to the size of the population from which customers are drawn (Winston, 1994).

[7]In an alternative setting, the customer can follow the strategy not to pick that particular supplier anymore in the event of disagreement; that is, he selects one of the $N-1$ remaining suppliers. Of course, this improves the customer's bargaining position when $N \geq 2$. It, however, does not affect the results fundamentally. The reason for choosing this particular setting is to introduce as much symmetry as possible compared to the *FIFO*-market. In addition, it makes the analysis somewhat cleaner.

selecting one of the N suppliers equals

$$\hat{v}_B = \max[0, \alpha(r - p_e)] \tag{1}$$

since leaving the market yields a zero surplus. One may wonder why Eq. (1) contains only a single p_e. Two situations can be distinguished. First, suppose there is no customer in the market. An entering customer can choose one of the N suppliers. His disagreement point is also determined by N suppliers. Second, suppose there is a customer in the market. A new entering customer can choose one of the $N - 1$ available suppliers. Each of these two customers anticipate the other will reach an agreement at price p_e — this anticipation is correct in equilibrium. Therefore, their disagreement points are also determined by N suppliers and exactly coincide with the first case.

In the event of agreement, the selected supplier S receives the expected payoff $\hat{w}_S$. It contains two terms. First, before a customer has arrived, this supplier will be matched with probability δ/N. If so, this yields an expected gain of $p_e - c$. Second, with the remaining probability $1 - \delta/N$ there is no match either because no customer arrived at all or there was a match with another supplier S'. In that case supplier S has to wait until the next period and arrives in exactly the same situation as before with the expected payoff of $\hat{w}_S$. Therefore,

$$\hat{w}_S = \delta(p_e - c)/N + (1 - \delta/N)\beta\hat{w}_S. \tag{2}$$

If, however, supplier S is matched but disagreement occurs, his expected discounted payoff equals $\hat{v}_S$. In this event, the current customer again selects one of the N suppliers, before a potentially entering new customer picks a supplier. After the current customer has randomly chosen a supplier, the new customer, if any, can choose from the $N-1$ remaining suppliers. Therefore, the supplier's discounted expected payoff from disagreement equals

$$\hat{v}_S = \begin{cases} \max[0, \beta(p_e - c)] & \text{if } N = 1 \\ \max[0, \beta((1+\delta)(p_e - c)/N + (1 - (1+\delta)/N)\beta\hat{w}_S)] & \text{if } N \geq 2 \end{cases} \tag{3}$$

since the supplier's option to leave the market yields a zero surplus. In the first part of Eq. (3), i.e. if $N = 1$, the supplier and customer are involved in a bilateral monopoly situation: the supplier can only negotiate with one customer and the current customer can pick the supplier before any potentially new entering customer. Therefore, in the event of disagreement, both must continue bargaining with each other in the next period. Part two applies if the number of sellers equals $N \geq 2$. It contains two terms: in the first term the current customer *or* the potentially new entering customer selects this same supplier S with probability $(1+\delta)/N$. If so, this yields an expected surplus of $p_e - c$ in the next period. The second term explains that with the remaining probability $(1-(1+\delta)/N)$, the current customer *and* the new entering customer (if any) pick *another* supplier S' in the next period. Since customers anticipate agreement at any other supplier S' in this next period, supplier S gets the discounted payoff $\hat{w}_S$. Thus, supplier and customer are involved in a partial bilateral monopoly situation: In the event of disagreement, there is a positive probability that the current supplier will not be matched in the next period. Rearranging Eq. (2) and substitution into part two of Eq. (3) yields

$$\hat{v}_S = \begin{cases} \max[0, \beta(p_e - c)] & \text{if } N = 1 \\ \max[0, \beta(1-\beta+\delta)(p_e - c)/(N(1-\beta)+\beta\delta)] & \text{if } N \geq 2. \end{cases} \tag{4}$$

A supplier's expected payoff in the event of disagreement approaches zero as the probability of any customer choosing this particular supplier tends to zero ($N \to \infty$). Similarly, when the probability of a new customer entering the market approaches zero ($\delta \to 0$), the supplier's expected payoff in the event of disagreement becomes $\beta(p_e - c)/N$. The disagreement point $\hat{v} \equiv (\hat{v}_B, \hat{v}_S)$ determines the surplus to the customer and the supplier, respectively, in case the bilateral negotiation breaks down. Both parties have an incentive to reach an agreement if the net surplus

$$r - \hat{v}_B - \hat{v}_S - c \tag{5}$$

is non-negative.[8] To determine the outcome of the bargaining process, assume that the customer and the supplier share the net surplus from reaching an agreement equally as in the symmetric Nash bargaining solution. Nash (1950) has provided axiomatic foundations for this solution. Binmore, Rubinstein, and Wolinsky (1986) have shown that the non-cooperative alternating offer bargaining model *à la* Rubinstein (1982) approaches Nash's axiomatic bargaining solution for the limiting case when the probability of an exogenous breakdown converges to zero. From the symmetric Nash bargaining solution concept, the customer receives his disagreement point $\hat{v}_B$ plus half of the net surplus $r - \hat{v}_B - \hat{v}_S - c$.

Therefore, the outcome $\hat{p}$ of the price negotiation satisfies the equation

$$r - \hat{p} = 0.5(r - \hat{v}_B - \hat{v}_S - c) + \hat{v}_B. \tag{6}$$

Definition 1: The outcome $\hat{p}$ is a random-market equilibrium if Eq. (6) is satisfied where $\hat{v}_B$ and $\hat{v}_S$ are as defined in Eqs. (1) and (4) such that (i) $r - \hat{p} \geq \hat{v}_B$ and $\hat{p} - c \geq \hat{v}_S$; and (ii) $\hat{p} = p_e \geq c$, $\hat{v} \geq 0$.

Part (i) is necessary to guarantee that customers and suppliers find it profitable to enter the market. Part (ii) guarantees that the outcome of the negotiation in the random-market equals at least the marginal cost c and satisfies Eq. (6), together with the rational expectations assumption and the disagreement points. To state the first proposition, define the parameter

$$R \equiv \frac{\beta(1 - \beta + \delta)}{N(1 - \beta) + \beta\delta}.$$

Proposition 1: *There is a unique random-market equilibrium $\hat{p}$. In this market equilibrium agreement is reached and given by*

$$\hat{p} = \frac{r(1-\alpha) + c(1-\beta)}{2 - \alpha - \beta} \quad \textit{if } N = 1, \quad \textit{and } \hat{p} = \frac{r(1-\alpha) + c(1-R)}{2 - \alpha - R} \quad \textit{if } N \geq 2. \tag{7}$$

[8] In equilibrium, this will be the case as the reader may easily verify.

Proof: From Eqs. (1), (4), and the assumption that $p_e = \hat{p}$, the outcome of the symmetric Nash bargaining solution is defined by Eq. (6) if the first inequality in (i) is satisfied. Since $r > c$, this first inequality in (i) is satisfied. Therefore, the customer's disagreement point is $\hat{v}_B = \alpha(r - \hat{p})$. Straightforward calculations show that the second inequality in (i) is always satisfied. Since $r > c$, the first inequality in (ii) is satisfied. Therefore, $\hat{v} \geq 0$ and agreement must be reached. Finally, when $\hat{p} = p_e$, the solution to Eq. (6) is unique and equivalent to Eq. (7). □

The outcome $\hat{p}$ when $N = 1$ is independent of the probability δ customers enter the market. The intuition is that once a customer has entered the market, the supplier knows with certainty he will be matched in the next period in the event of disagreement. Therefore, the probability of a new customer entering the market has no effect on the supplier's disagreement point. The supplier and customer are involved in a bilateral monopoly situation.

The outcome $\hat{p}$ when $N \geq 2$ has the following properties. An increase in the probability δ with which customers enter the market positively affects $\hat{p}$. The intuition is that customer and supplier are involved in a partial bilateral monopoly and an increase in δ augments the supplier's disagreement point. An increase in the number of suppliers N, however, decreases the supplier's probability of being matched. This affects the supplier's disagreement point negatively and thus decreases $\hat{p}$. In the limit when $N \to \infty$, the right hand side of Eq. (7) equals $(r(1-\alpha)+c)/(2-\alpha)$ and is thus independent of β and δ. If, moreover, in the limit $\alpha \to 1$, the negotiated outcome approaches marginal cost c. When $\alpha, \beta, \delta \to 1$, the outcome approaches $(r + c(N-1))/N$.

5.4 The *FIFO*-market

If the supplier's market is organized as a *FIFO*-system, every supplier has a well-defined position in the queue. Upon his arrival at the location where suppliers wait at stand, the customer has two alternatives. The first is to leave the market, yielding a zero surplus. The other alternative obliges the customer to pick the first supplier in the queue. In case of selecting this first supplier, the customer can find out the price only through bilateral negotiation. If this current customer finds the negotiated price unattractive, he can stay in the market or leave the market. As in the random-market, this current customer picks a supplier before a potentially new customer enters. Since the market is organized as a *FIFO*-system, the current customer has to continue the bargaining in the next period with the same supplier. In this next period, a new customer has to select the supplier with rank two in the queue if the current customer has not reached an agreement.[9] If, however, both customers cannot reach an agreement, they both continue bargaining with the same supplier and another new customer selects the supplier with rank three, and so on. The bargaining surplus is available upon agreement. In this *FIFO*-market, both trading partners are involved in a bilateral monopoly situation. In consequence, the customer's and supplier's expected payoff in the event of disagreement equals

$$\tilde{v}_B = \max[0, \alpha(r - p_e)], \qquad \tilde{v}_S = \max[0, \beta(p_e - c)], \tag{8}$$

respectively. The disagreement point $\tilde{v} \equiv (\tilde{v}_B, \tilde{v}_S)$ represents the surplus to the customer and the supplier, respectively, in case the bilateral negotiation breaks down. The net surplus from reaching an agreement in the *FIFO*-market is

$$r - \tilde{v}_B - \tilde{v}_S - c \tag{9}$$

and must be non-negative.[10] In the symmetric Nash bargaining solution, the outcome $\tilde{p}$ of the price negotiation satisfies the equation

[9]This way of modelling is a fairly robust set-up: suppose that when a potentially new customer has arrived, he chooses with probability $0 \leq \rho \leq 1$ before the current customer. If, however, no new customer has arrived, the current customer has to continue the bargaining with the first supplier. In this set-up, the supplier first in rank has with probability one a customer in the next period. Similarly, since all suppliers are alike, the customer's disagreement point remains the same.

[10]This will be the case in equilibrium.

$$r - \tilde{p} = 0.5(r - \tilde{v}_B - \tilde{v}_S - c) + \tilde{v}_B. \tag{10}$$

Definition 2: The outcome $\tilde{p}$ is a *FIFO*-market equilibrium if Eq. (10) is satisfied where $\tilde{v}_B$ and $\tilde{v}_S$ are as defined in Eq. (8) such that (i) $r - \tilde{p} \geq \tilde{v}_B$ and $\tilde{p} - c \geq \tilde{v}_S$ and (ii) $\tilde{p} = p_e \geq c$, $\tilde{v} \geq 0$.

The interpretation of (i) and (ii) is similar to the conditions in Definition 1.

Proposition 2: *There is a unique FIFO-market equilibrium $\tilde{p}$. In this equilibrium agreement is reached and given by*

$$\tilde{p} = \frac{r(1-\alpha) + c(1-\beta)}{2 - \alpha - \beta}. \tag{11}$$

Proof: From the customer's and the supplier's disagreement points, and the assumption that $p_e = \tilde{p}$, the outcome of the symmetric Nash bargaining solution is defined by (10) if $r \geq \tilde{p}$. Since $r > c$, the customer's disagreement point is non-negative. Therefore, the customer's disagreement point equals $\tilde{v}_B = \alpha(r - \tilde{p})$ and the first inequality in (i) is satisfied. Straightforward manipulations show that the second inequality is always satisfied. Therefore, $\tilde{v} \geq 0$ and agreement is reached. Finally, if $\tilde{p} = p_e$, the solution to Eq. (10) is unique and equals Eq. (11). □

Equation (11) is independent of the probability δ with which customers enter the market. The intuition of this observation is the following: once a customer has entered the market, the supplier ranking in front of the queue knows with certainty he will be matched again with this customer in the event of disagreement. That is, the customer is locked in forever. Therefore, the probability of a new customer entering the market becomes completely irrelevant. Equation (11) is also independent of the number of suppliers in the queue. Again, the intuition is that if a customer enters the market, the supplier ranking in front of the queue is matched with certainty. Consequently, the total number of suppliers plays no role.

A comparison of the prices in the two regimes yields that $\tilde{p} \geq \hat{p}$: the outcome of the negotiation in the *FIFO*-market is at least as high as in the random-market. The intuition behind this result is simple: the random-system implies more degrees of freedom for the customers. As a result, customers are relatively in a better bargaining position. The equality sign holds if $N = 1$. It also holds if $N = 2$ and $\delta = 1$. In both these scenarios, the supplier knows for sure he will be matched in the next period. This gives him effectively a bilateral monopoly situation as in the *FIFO*-market. In the limit, when $\beta \to 1$, the two equilibrium prices converge to the reservation value r. Similarly, when $\alpha \to 1$, both prices converge to the marginal cost c.

So far, the analysis has assumed that either the random- or the *FIFO*-regime are available. Suppose, however, that both regimes operate. Customers can distinguish and may costlessly choose between the random- and the *FIFO*-regime. Obviously, customers will select a supplier in the random-regime as the negotiated outcome there is never larger than in the *FIFO*-regime. Consequently, all the *FIFO*-suppliers have no chance of making positive profits. They find it optimal to join the random-regime. The *FIFO*-suppliers, however, survive when both stands are separated and customers cannot choose regime. The following section demonstrates that this is, indeed, the case: suppliers face a trade-off between the two market organizations.

5.5 Stability of Market Organization

Sections 3 and 4 assume that customers and suppliers cannot choose the regime. This section assumes that there is a random- and a *FIFO*-market organization. Before the markets open, every supplier chooses once and for all which system he will join. Customers, however, cannot choose between the two systems. The two market organizations, therefore, are completely separated. One interpretation may be that customers do not know in advance where they will arrive. In addition, they cannot switch from one regime to the other; prohibitive switching costs or ignorance about the existence of another stand offer a reasonable economic justification for this assumption. This section deals with the stability of the two market organizations against each other. A market organization is said to be stable against the other only if no supplier can gain by switching to the other market organization, given the decision of all other suppliers. The supplier's decision whether to join a particular market organization or not depends on his expected payoff. Before providing a precise definition of stability of market organization, we compute the suppliers' expected payoffs for the two market organizations.

Let N_1 be the number of suppliers joining the random-system. Similarly, let $N_2 = N - N_1$ be the number of suppliers joining the *FIFO*-system. As computed in Section 3, each supplier's expected payoff from agreement in the random-market equals $\hat{w}_S$ as in Eq. (2) with $p_e = \hat{p}$. Therefore,

$$\hat{w}_S(N_1) = \frac{\delta(\hat{p} - c)}{N_1(1 - (1 - \delta/N_1)\beta)}. \tag{12}$$

Market frictions allow suppliers to make positive profits. These profits increase when β becomes larger, but decrease with α. Equation (12) holds for every supplier in the random-market and depends on the *total* number of suppliers. It is decreasing in the number of suppliers N_1, but increasing in δ.

The expected payoff $\tilde{v}_S(\tau)$, with $\tau = 1, ..., N_2$, for a supplier in the *FIFO*-market depends on his position in the queue. The supplier first in rank expects with probability δ a payoff of $\tilde{p} - c$ at the beginning of the current period. With the remaining probability, no customer has entered the market. In that case, he discounts his expected payoff $\tilde{v}_S(1)$ of the next period. Accordingly,

$$\tilde{v}_S(1) = \delta(\tilde{p} - c) + (1 - \delta)\beta\tilde{v}_S(1)$$

or

$$\tilde{v}_S(1) = \frac{\delta(\tilde{p} - c)}{1 - (1 - \delta)\beta}. \tag{13}$$

Similarly, the supplier with position $2 \leq \tau \leq N_2$ has, in the beginning of the same current period, an expected discounted payoff of

$$\tilde{v}_S(\tau) = \beta(\delta\tilde{v}_S(\tau-1) + (1-\delta)\tilde{v}_S(\tau))$$

or,

$$\tilde{v}_S(\tau) = \frac{\beta\delta}{1-(1-\delta)\beta}\tilde{v}_S(\tau-1) \tag{14}$$

so that, given Eq. (13) the recursive solution of Eq. (14) equals

$$\tilde{v}_S(\tau) = \beta^{\tau-1}[\frac{\delta}{1-(1-\delta)\beta}]^{\tau}(\tilde{p}-c). \tag{15}$$

Equation (15) is decreasing in the supplier's position τ in the queue. In contrast with the random-market, a supplier's expected payoff depends on the number of suppliers *in front of* him; *not* on the total number of suppliers in the *FIFO*-market. The suppliers' profits in the *FIFO*-regime are increasing in δ. In the limit when $\delta \to 1$ or $\beta \to 1$, the term between square brackets approaches one. Profits are positive in the presence of market frictions. In particular, they are increasing in β but decreasing in α.

Equations (12) and (15) become identical for $N_1 = \tau = 1$. In words, suppose there is only one supplier in the random-market. This supplier has exactly the same expected discounted profit as the supplier in the *FIFO*-market with position one. Obviously, when $N = 1$, the supplier is indifferent between the two regimes. The rest of the analysis, however, assumes $N \geq 2$. In addition, to keep the analysis as tractable as possible, assume that $c = 0$. Before stating the following proposition define the functions

$$\begin{aligned} F_1(N_1) &\equiv \frac{(1-(1-\delta)\beta)\hat{p}(N_1)}{(N_1(1-\beta)+\beta\delta)\tilde{p}} \\ &= \frac{(1-(1-\delta)\beta)(2-\alpha-\beta)}{(2-\alpha)(N_1(1-\beta)+\beta\delta)-\beta(1-\beta+\delta)}, \end{aligned} \tag{16}$$

$$F_2(N_1) \equiv \left(\frac{\beta\delta}{1-(1-\delta)\beta}\right)^{N-N_1}, \tag{17}$$

and

$$
\begin{aligned}
F_3(N_1) &\equiv \frac{\beta\delta\hat{p}(N_1+1)}{((N_1+1)(1-\beta)+\beta\delta)\tilde{p}} \\
&= \frac{\beta\delta(2-\alpha-\beta)}{(2-\alpha)(N_1+1)(1-\beta)+\beta\delta)-\beta(1-\beta+\delta)},
\end{aligned}
\tag{18}
$$

where $\hat{p}(N_1)$ and $\hat{p}(N_1+1)$ denote the outcome of the random-market equilibrium with N_1 and N_1+1 suppliers, respectively. The three functions are positively valued. The function $F_2(\cdot)$ is increasing and reaches its maximum value of one at $N_1 = N$. Note that $F_1(\cdot)$ and $F_3(\cdot)$ are decreasing and $F_1(1) = 1$. Moreover, we unambiguously have that $F_1(N_1) \geq F_3(N_1)$.

Definition 3: The random- and the *FIFO*-market form an (N_1, N_2)-equilibrium if N_1 and N_2 are such that (i) $\hat{w}_S(N_1) \geq \tilde{v}_S(N_2+1)$ and (ii) $\tilde{v}_S(N_2) \geq \hat{w}_S(N_1+1)$.

Part (i) of this definition guarantees that no supplier in the random-market has an incentive to switch to the *FIFO*-market. It assumes that this supplier, when switching to the *FIFO*-regime, is appointed the last position in the queue. If part (ii) also holds, no supplier in the *FIFO*-regime gains by deviating to the random-regime. Since $\tilde{v}_S(\tau)$ is decreasing, it suffices to consider the supplier with position $\tau = N_2$.

Proposition 3: *In any (N_1, N_2)-equilibrium it is the case that $N_1 > 0, N_2 > 0$; i.e. there are suppliers in both markets.*

Proof: Conditions (i) and (ii) in Definition 3 hold if and only if $F_1(N_1) \geq F_2(N_1) \geq F_3(N_1)$. Suppose $N_2 = 0$, from which the second term equals one, whereas the first and third term are less than one since, by assumption, $N \geq 2$. Therefore, the first inequality can never be satisfied if $N_2 = 0$. Suppose now that $N_1 = 0$. Since we now have that $N_2 \geq 2$, the supplier with the last position certainly has an incentive to deviate: a random-market with only one supplier effectively becomes a bilateral monopoly and replicates the *FIFO*-regime. These findings imply that there exists no (N_1, N_2)-equilibrium with $N_1 = 0$ or $N_2 = 0$. □

In essence, Proposition 3 shows that, there is no (N_1, N_2)-equilibrium with all suppliers operating in one or the other regime. Although the *FIFO*-market yields higher prices, it is still profitable for part of the suppliers to operate in the random-market. The supplier with the last position in the queue faces a trade-off between the two regimes. On the one hand, sticking to the *FIFO*-market yields a high price, but the waiting time can be very costly. On the other hand, switching to the random-market drastically decreases the expected waiting time, but results in a lower negotiated outcome. A similar argument goes through for every supplier in the random-market. In equilibrium, no supplier has an incentive to switch regime.

Proposition 4: *For each fixed total number of suppliers N there exists an (N_1, N_2)-equilibrium.*

Proof: Denote by $\overline{N}_1$ the value of N_1 for which $F_1(N_1) = F_2(N_1)$. Similarly, let $\underline{N}_1$ be the value of N_1 for which $F_2(N_1) = F_3(N_1)$. We know that $F_1(1) = 1 > F_2(1)$. Since $F_1(N_1) \geq 0$, $F_1'(N_1) < 0$, and $F_2'(N_1) > 0$ we have that $F_1(N_1) \geq F_2(N_1)$ for all $N_1 \leq \overline{N}_1$ and $F_1(N_1) \leq F_2(N_1)$ if $N_1 \geq \overline{N}_1$. Since $F_3'(N_1) < 0$ and $F_1(N_1) \geq F_3(N_1)$, there exists at most one $\underline{N}_1$ such that $F_2(N_1) \leq F_3(N_1)$ for all $N_1 \leq \underline{N}_1$ and $F_2(N_1) \geq F_3(N_1)$ if $N_1 \geq \underline{N}_1$. Since $N \geq 2$ and $F_1(N_1)$ is unambiguously larger than $F_3(N_1)$ it follows that $1 \leq \underline{N}_1 \leq \overline{N}_1 \leq N$. Therefore, for any N there always exists a value of N_1 such that $\underline{N}_1 \leq N_1 \leq \overline{N}_1$. These values of N_1 satisfies condition (i) and (ii) of Definition 3. □

Proposition 4 ignores any integer problem, and states that there is always a combination of N_1 and N_2 such that no supplier has an incentive to switch to the other regime. There is always a lowest $(\underline{N}_1)$ and highest $(\overline{N}_1)$ number of suppliers in the random-market supporting an equilibrium. Any combination of suppliers with N_1 between these two bounds satisfies the equilibrium conditions.

Since $N_1 = N - N_2$, one could also establish Proposition 4 in terms of N_2, the number of suppliers in the *FIFO*-regime. The Eqs. (16) – (18) can then be expressed as a function of N_2. The functions $F_1(\cdot)$ and $F_3(\cdot)$ are now increasing in N_2, while $F_2(N_2)$ is decreasing. Use of the same notation and construction of an analogous proof shows that for any N there always exists a value of N_2 such that $1 \leq \underline{N}_2 \leq N_2 \leq \overline{N}_2 \leq N$.

Proposition 5: *If N increases, then the lowest and highest number of suppliers in both the random-market and* FIFO*-market that form an* (N_1, N_2)*-equilibrium also increase.*

Proof: An increase in N implies a downwards shift for $F_2(\cdot)$. The functions $F_1(\cdot)$ and $F_3(\cdot)$, however, are not affected. From the properties of $F_1(\cdot)$ it follows that $\overline{N}_1$ also increases. Similarly, a decrease in $F_2(\cdot)$ shifts the point of intersection with $F_3(\cdot)$ to the right so that $\underline{N}_1$ augments. Therefore, the lowest and highest number of suppliers in the random-market increases with N. To prove the increases in the *FIFO*-market, substitute N_1 for $N - N_2$ in Eqs. (17) – (19). An increase in N does not affect $F_2(\cdot)$, while the functions $F_1(\cdot)$ and $F_3(\cdot)$ are shifted downwards. From the properties of these functions, it follows that both $\underline{N}_2$ and $\overline{N}_2$ augment when N increases. □

Proposition 5 demonstrates that in any (N_1, N_2)-equilibrium, an increase in the total number of suppliers augments the lower and upper bound of the number of suppliers in both regimes. This result has the following intuition: an increase in the number of suppliers in the random-market decreases its profitability. Therefore, the cut-off point of profitability at which suppliers still join the *FIFO*-market without an incentive for switching also decreases. By consequence, the possible lowest and highest number of suppliers in the *FIFO*-market also increases. The same intuition holds when the number of suppliers in the *FIFO*-market increases.

Figure 1 illustrates Propositions 4 and 5. The horizontal axis depicts the number of suppliers in the *FIFO*-market. The vertical axis shows the number

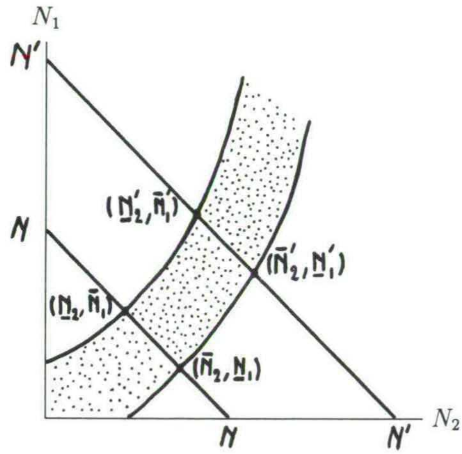

Figure 1: The (N_1, N_2)-equilibrium.

of suppliers in the random-market. On the straight line NN, the total number of suppliers N remains constant. On the higher straight line $N'N'$ the total number of suppliers equals N', with $N' > N$. There is an (N_1, N_2)-equilibrium for every combination of N_1 and N_2 in the dotted region. Proposition 4 shows that each line along which the total number of suppliers is constant crosses the dotted region. Proposition 5 establishes that when the total number of suppliers increases, the lowest and highest equilibrium number of suppliers in each regime also increase. When the number of suppliers becomes larger and larger, the lowest and highest number of suppliers supporting an equilibrium approach each other. In the limit when N goes to infinity, the dotted region shrinks to a single line. Figure 1 illustrates that $\underline{N}_i < \underline{N'}_i$ and $\overline{N}_i < \overline{N'}_i$, with $i = 1, 2$.

The suppliers' decision to join one or the other regime depends on the relative values of the underlying parameters. The functions $F_1(\cdot)$ and $F_3(\cdot)$ are increasing in α, while $F_2(\cdot)$ remains unchanged. Therefore, the values for $\underline{N}_1$ and $\overline{N}_1$ are decreasing when the customers become more and more patient. The values of $\underline{N}_2$ and $\overline{N}_2$, by consequence, are increasing when the customers' degree of patience augments. However, when the customers become infinitely patient as α equals one, prices in both regimes approach zero, so that suppliers are indifferent. The values for $\underline{N}_1$ and $\overline{N}_1$ are also decreasing in β. As the suppliers' patience increases, the *FIFO*-regime becomes more profitable than the random-regime. Of course, when the suppliers do not discount the future anymore, they are indifferent between the two regimes. To see this observe that in the limit when $\beta \to 1$, prices in both regimes approach r. The Eqs. (16), (17), and (18) then converge to 1, so that every (N_1, N_2)-combination satisfies Definition 3. A higher probability δ with which a new customer enters the market also favors the equilibrium number of suppliers in the *FIFO*-regime.

When N is relatively small, the cost of waiting before serving a customer is relatively low for the *FIFO*-supplier with the last position. This favors the number of suppliers joining the *FIFO*-regime. As N becomes larger, however, the cost of waiting becomes fairly high. As a consequence, for large enough N more suppliers prefer to join the random-regime per supplier joining the *FIFO*-regime. The following proposition states that in the limit, when $N \to \infty$, the rate between N_1 and N_2 approaches infinity.

Proposition 6: *When $N_1 + N_2 \to \infty$, we find that for any (N_1, N_2)-equilibrium $N_1/N_2 \to \infty$.*

Proof: Condition (i) and (ii) in Definition 3 hold if and only if

$$\varphi_1(N_2)/N_2 \geq N_1/N_2 \geq \varphi_2(N_2)/N_2, \tag{19}$$

with

$$\varphi_1(N_2) \equiv \frac{\beta(1-(1-\alpha)\delta-\beta)}{(2-\alpha)(1-\beta)} \tag{20}$$

$$+\frac{(1-(1-\delta)\beta)(2-\alpha-\beta)}{(2-\alpha)(1-\beta)} / \left(\frac{\beta\delta}{1-(1-\delta)\beta}\right)^{N_2},$$

and

$$\varphi_2(N_2) \equiv \frac{\alpha(1-(1-\delta)\beta)-\beta^2+\beta(3-\delta)-2}{(2-\alpha)(1-\beta)} \tag{21}$$

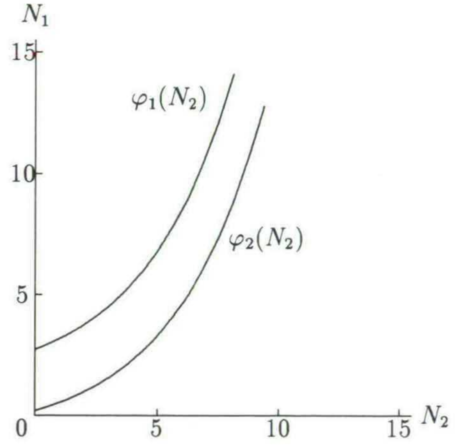

Figure 2: The functions $\varphi_1(\cdot)$ and $\varphi_2(\cdot)$

$$+\frac{\beta\delta(2-\alpha-\beta)}{(2-\alpha)(1-\beta)} / \left(\frac{\beta\delta}{1-(1-\delta)\beta}\right)^{N_2}.$$

Since $\lim_{N_2\to\infty}\varphi_i(N_2)=\infty$ and $\partial^2\varphi_i(N_2)/\partial N_2^2>0$ for all N, one has $\lim_{N_2\to\infty}[\varphi_i(N_2)/N_2]=\infty$, for $i=1,2$. For any N_1/N_2 satisfying Eq. (19), this implies $N_1/N_2\to\infty$ as $N_2\to\infty$. As N goes to infinity, in any (N_1,N_2)-equilibrium N_1/N_2 must go to infinity. □

Figure 2 gives a representative plot of the functions $\varphi_1(\cdot)$ and $\varphi_2(\cdot)$ for $\alpha=\beta=\delta=0.8$.

5.6 Conclusion

This chapter has studied how in a market with switching costs the organization of supply influences the bargaining outcome. Supply is offered simultaneously in the random-market. In such a market, a customer can randomly pick any supplier. Supply is offered according to the 'first-in first-out' (FIFO) principle in a market with sequential supply. In such a *FIFO*-market a customer picks the supplier in front of the queue. The negotiated outcome in the random-market results from a partial bilateral monopoly situation. With sequential supply, however, customer and supplier are involved in a bilateral monopoly. The *FIFO*-market, therefore, leads to a higher negotiated outcome than with simultaneous supply. Suppliers, however, do not always prefer the *FIFO*-market. When the two market organizations are present and customers cannot choose one or the other, the supplier with the last position in the *FIFO*-market trades off the cost of waiting time against the higher negotiated outcome. If suppliers can choose either to join one or the other regime, the market equilibrium has the property that there are always suppliers in both regimes.

A number of important assumptions have been made in this chapter. First, customers could not choose between the market organizations. Obviously, as already mentioned at the end of Section 5.4, customers choose that market organization offering the lowest negotiated outcome. A costless choice between these two market organizations, therefore, gives the *FIFO*-suppliers no chance of making positive profits.

Second, the chapter assumes that both regimes operate. Suppliers can only choose which regime to join. If the suppliers could ex ante coordinate on the type of market organization, they would certainly choose the one with the highest expected payoff per supplier. To see this, consider two stands A and B. Assume suppliers can in some way or another choose whether to be organized as a random- or *FIFO*-market. Suppose stand A chooses the random-system and stand B chooses the *FIFO*-system and $N_1^A > N_2^B$; that is, the number of suppliers is higher in the random-market. Of course, given stand A's choice of organization, the suppliers at stand B can improve their profits by transforming their stand into a random-market. In that case, the number of suppliers becomes the same at both stands. By consequence, the number of suppliers at stand A must decrease. In other words, the expected discounted profit goes up at stand A, and therefore also at stand B. A similar argument applies when $N_1^A < N_2^B$: suppliers at stand A can improve their profits when becoming a *FIFO*-market. This, however, does not rule out that both organizations can never operate simultaneously. Owners of a stand, such as airports, sell licenses to taxis. The owner maximizes the *total* expected pay-off of the stand. A priori, it is not impossible that each owner maximizes his payoffs when both systems operate.

Third, this model has assumed that suppliers get with probability one the last position in the *FIFO*-system. If other possible positions receive positive weight, joining the *FIFO*-system certainly becomes more attractive.

Fourth, every customer has an identical reservation value. This assumption is partly responsible for immediate agreement. Differences across customers with respect to their reservation values, however, could give rise to disagreement. The reason for rejection may be that a supplier expects a better deal to arrive in the future. Disagreement could also occur when the reservation value is not commonly known.

Fifth, the optimal number of suppliers and waiting time issues have not been addressed.[11] In this model, the arrival process of customers implies that every number of suppliers waiting in line exceeding one constitutes a social waste. A more elaborate model, e.g. with demand effects, would be wellcomed to address social welfare issues in more detail.

Finally, other scenarios such as the already mentioned *tour de rôle* system on the North-South inland waterways transport market could be looked at in more

[11] See Beesley and Glaister (1983), Brunstad (1991), and Burdett and Fölster (1994) for an analysis of these issues in the cruising taxi market.

detail. Upon disagreement, a shipper switches to the second barge in the queue. The first bargeman, however, keeps his position in front of the queue. In such a scenario, the bargeman's disagreement point equals $\tilde{v}'_S = \max[0, \beta\delta(p_e - c)]$ since a new entering shipper enters with probability δ. It can easily be shown that for high enough δ, or $N \geq \beta[(2 - \beta - \delta)/(1 - \beta)\delta]$ the negotiated outcome of the *tour de rôle* system always results in a higher price. When $\delta \rightarrow 1$, the *tour de rôle* system approaches the framework used in the current chapter. This model, therefore, illustrates that when the probability of arrival of a shipment is high enough, such a *tour de rôle* system could be judged as a restrictive practice.

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Summary in Dutch

Het essay 'Phonebanking' bestudeert het effect van een nieuwe transactie-technologie op de competitie tussen twee banken. Deze twee financiële instellingen maximaliseren hun winsten door deposito's aan te trekken. De depositohouders bevinden zich in een geografische ruimte (een cirkel) en hebben een aantal banktransacties te verrichten. Sommige van deze transacties vereisen een bezoek aan het bankkantoor. De kost van elk bezoek aan het bankkantoor stijgt met de afstand tussen het bankkantoor en de woonplaats van de depositohouder. Andere transacties vereisen geen bezoek aan het kantoor en kunnen op afstand, bv. per telefoon, afgehandeld worden. Dit noemen we 'telefoonbankieren'. De kost van zo'n transactie is onafhankelijk van de afstand tussen het bankkantoor en de woonplaats van de depositohouder. De kost van telefoonbankieren is voor elke depositohouder lager dan een bezoek aan het bankkantoor. Met andere woorden, indien voor een bepaalde transactie bankieren per telefoon mogelijk is, dan verkiest elke depositohouder dit boven een bezoek aan zijn kantoor. Het aanbieden van de optie telefoonbankieren betekent dus voor elke depositohouder een verhoging in de aangeboden kwaliteit. De twee banken hebben een vaste locatie op de cirkel en concurreren met elkaar als volgt: in een eerste fase beslist elke bank over het al dan niet aanbieden van de optie telefoonbankieren. Wanneer deze beslissing genomen en bekend is concurreren de twee banken met elkaar op basis van interestvoeten. Het aanbieden van de optie telefoonbankieren creëert twee effecten die diametraal tegenover elkaar staan. Het eerste effect is een 'vraageffect': elke bank die de optie telefoonbankieren aanbiedt, beïnvloedt op een positieve manier zijn marktaandeel. De verklaring is dat elke depositohouder een kost van een transactie per telefoon verkiest boven de kost van een verplaatsing naar het bankkantoor. Het tweede effect is het 'strategisch effect': de optie telefoonbankieren wakkert de competitie in interestvoeten aan. De verklaring is dat een verlaging van de transactiekosten de twee banken 'dichter' bij elkaar brengt. Anders gezegd, de depositohouders beschouwen de twee banken als meer substitueerbaar voor elkaar. Dit leidt tot scherpere concurrentie in interestvoeten. Wanneer dit strategisch effect domineert, dan zal geen van beide banken de optie telefoonbankieren aanbieden. Het omgekeerde geldt wanneer het vraageffect domineert. In dat geval bieden beide banken de optie aan. Slechts één van beide banken biedt de optie aan indien er een relatief groot vraageffect is in combinatie met een gematigd strategisch effect.

Het essay 'Monopolistic Competition with a Mail Order Business' is in termen van opzet nauw gerelateerd aan het hierboven beschreven essay. Deze tweede bijdrage analyseert een markt met homogene goederen. Bedrijven hebben twee opties om hun waar aan de man brengen. De eerste optie is het openen van een winkel. De kost voor de consument van een aankoop in een winkel stijgt met de (fysische) afstand tussen die winkel en de woonplaats van de consument. De andere optie is het openen van een postorderbedrijf. Deze verkoopstrategie impliceert dat de consument een vaste kost betaalt voor zijn aankoop bij het postorderbedrijf. Met andere woorden, de kost van aankoop is voor de consument onafhankelijk van de (fysische) afstand tussen de consument en het postorderbedrijf. Net zoals in het eerste essay bevinden de consumenten zich op een cirkel. Bedrijven die een winkel openen krijgen een locatie op de cirkel toegewezen. Het middelpunt van de cirkel is een interpretatie voor de locatie van een postorderbedrijf: de kost van de (fysische) afstand tussen elke consument en een postorderbedrijf is identiek. De opzet is als volgt: in een eerste fase beslist elk bedrijf om al dan niet toe te treden tot de markt. Daarna beslist elk bedrijf op welke manier ze haar waar aan de man brengt: via een winkel of via een postorderbedrijf. In een derde fase concurreren de bedrijven met elkaar door middel van prijzen. De belangrijkste resultaten van dit essay zijn: er bestaat ten hoogste één postorderbedrijf. De intuitie is dat twee of meer postorderbedrijven geen enkele ruimte vinden om zich van elkaar te differentiëren. Bijgevolg concurreren ze zichzelf kapot. Het openen van een winkel garandeert echter voldoende differentiatie van elke ander winkel. Het is dus nooit optimaal om als postorderbedrijf te concurreren met een ander postorderbedrijf. Een ander inzicht is dat het postorderbedrijf met elke winkel concurreert. Omgekeerd concurreert elke winkel met hetzelfde postorderbedrijf. Figuur drie op pag. 59 illustreert dit duidelijk: het postorderbedrijf wringt zichzelf tussen elk paar winkels op de cirkel. De consumenten die relatief ver van elke winkel wonen verkiezen hun waar bij het postorderbedrijf te kopen. Tenslotte, de mogelijkheid om de aangeboden waar via een postorderbedrijf te verkopen verhoogt de concurrentie. Het hoger aantal bedrijven dat tot de bedrijfstak wenst toe te treden indien er geen postorderbedrijf toegelaten wordt maakt dit duidelijk.

Het derde essay heet 'Price Competition between an Expert and a Non-expert'. Een hoeveelheid consumenten probeert elk tegen minimale kosten bv. een goed te herstellen. Elke consument heeft twee mogelijkheden. De eerste mogelijkheid is om onmiddellijk aan te kloppen bij de vakman (de expert): hij repareert het defecte goed met zekerheid. De andere mogelijkheid is om de klusjesman (de non-expert) uit te proberen. Deze klusjesman repareert het defecte goed slechts met een bepaalde (bekende) kans. Indien na het bezoek blijkt dat de klusjesman niet in staat was het defecte goed te herstellen, is een tweede bezoek bij hem volledig nutteloos: de consument weet nu dat de klusjesman het in geen geval kan herstellen. Er rest deze consument nog slechts één mogelijkheid: de vakman. De consument moet dus een optimale beslissing maken tussen (i) kiezen voor zekerheid door onmiddellijk bij de vakman aan te kloppen maar tegen een hoge prijs, of (ii) zijn kans wagen bij de klusjesman tegen een lage prijs maar met het risico dat een bezoek aan de vakman toch nog nodig zal zijn. De consumenten bevinden zich op een lijnstuk en betalen een transportkost om zich naar de vakman of de klusjesman te begeven. Deze transportkost stijgt met de af te leggen afstand. De vakman bevindt zich aan het ene, de klusjesman bevindt zich aan het andere uiteinde van dit lijnstuk. De vakman staat voor de volgende beslissing: ofwel vraagt hij een heel hoge prijs waardoor elke consument beslist om eerst bij de klusjesman aan te kloppen. In dat geval bedient hij enkel die consumenten die bij de klusjesman geen geluk hadden. De andere keuze is een agressieve prijs vragen. In dat geval zijn er toch nog consumenten die het optimaal vinden om onmiddellijk bij de vakman aan te kloppen. De vakman zal een agressieve prijs zetten wanneer de kans op succesvol herstel bij de klusjesman voldoende hoog is. Immers, het aantal consumenten dat geen geluk had bij de klusjesman is heel laag. Dit maakt het vragen van een hoge prijs heel onaantrekkelijk voor de vakman. Wanneer de kans op succesvol herstel bij de klusjesman laag is, dan wordt het voor de vakman aantrekkelijk om een hogere prijs te vragen. Uit de analyse blijkt dat de vakman met een bepaalde kans de monopolieprijs zal vragen. Met de andere kans zet hij een lage prijs. Vanuit efficiëntie-oogpunt is er nog het volgende inzicht: wanneer de vakman een kostennadeel ondervindt gaan te weinig consumenten eerst naar de klusjesman. Het omgekeerde gebeurt wanneer er geen kostenverschillen zijn tussen de vakman en de klusjesman. Deze bijdrage kan ook gezien worden als een eerste aanzet om de effecten van verwijzing (Nederland) of echelonering (België) te bestuderen in de zorgverstrekkende sector.

Essay vier is getiteld 'Bargaining in Markets with Simultaneous and Sequential Suppliers' en vergelijkt twee marktorganizaties waar verkopers (bv. taxichauffeurs) wachten op klanten. In de ene marktorganisatie (de random-markt) kan een klant met om het even welke verkoper een transactie afsluiten. Indien de twee partijen niet tot een overeenkomst kunnen komen, dan kan de klant in de volgende periode naar om het even welke verkoper toestappen om een transactie af te sluiten. In de andere marktorganisatie (de FIFO-markt) moet de klant de volgorde van de rij wachtende verkopers respecteren: de verkoper die vooraan in de rij staat heeft het recht om met de eerste klant een transactie af te sluiten. De klant heeft niet het recht om een andere verkoper te kiezen. Indien de twee partijen geen overeenkomst kunnen bereiken, dan blijft de klant in de volgende periode toegewezen aan diezelfde verkoper. Er wordt verondersteld dat alle klanten dezelfde karakteristieken vertonen. Daarenboven komt er per tijdseenheid ten hoogste één klant binnen. Het aantal verkopers wordt constant gehouden. De prijs komt tot stand via bilaterale onderhandeling. De onderhandelingsprijs heeft als kenmerk dat beide partijen de helft van het beschikbare surplus krijgen. Het onderhandelingsproces wordt echter niet gemodelleerd. De belangrijkste resultaten zijn: de onderhandelde prijs in de random-markt is nooit hoger dan de onderhandelde prijs in de FIFO-markt. De intuitie is dat de onderhandelingen in de random-markt het kenmerk hebben van een partieel bilateraal monopolie: de klant kan in de volgende periode naar een andere verkoper overstappen. Dit maakt dat de klant een lagere prijs kan afdwingen. In de FIFO-markt kan de klant dit niet afdwingen: vermits de klant bij dezelfde verkoper moet blijven komt de prijs tussen de klant en de verkoper tot stand in een context van een bilateraal monopolie. Wanneer beide marktorganisaties aanwezig zijn en de klanten niet kunnen kiezen in welk systeem ze zullen belanden, dan blijft de random-markt niettegenstaande haar lagere prijs altijd aantrekkelijk. Een lange wachtrij betekent voor de FIFO-verkoper met de laatste positie een kostbare wachttijd. Deze verkoper weegt de hoge prijs en kostbare wachttijd van de FIFO-markt af tegen de lagere prijs en minder dure wachttijd van de random-markt. Wanneer het aantal verkopers laag is, dan verkiest een relatief hoog aantal verkopers de FIFO-markt. Wanneer het aantal verkopers heel hoog wordt, verkiest een relatief hoog aantal verkopers de random-markt.

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JAN BOUCKAERT studied Economics at the Katholieke Universiteit Leuven and received his M.A. in Economics from the Université Catholique de Louvain. He carried out his PhD research at the CentER for Economic Research (Tilburg University).

This dissertation contains four essays in theoretical industrial organization. The introduction offers the reader some background on the relevant literature. The first three essays make use of two well-known models of spatial competition: the linear model and the circular model. The first essay studies under what conditions banks offer the service phonebanking. It combines the concepts of horizontal and vertical product differentiation. The second essay explores a market in which firms can choose to sell either by a retail store or a mail order business. This essay merges some ideas on localized and nonlocalized competition. The third essay investigates price competition between an expert and a non-expert. The expert, in contrast with the non-expert, always repairs successfully. As in the first essay, it deals with horizontal and vertical product differentiation. The fourth essay uses bargaining theory and compares the outcome of a negotiation in two differently organized markets. In the first market, sellers simultaneously offer their good or service for sale. In the second market, sellers queue and offer their good or service sequentially for sale. Relevant markets are the taxi market and the inland waterways transport markets.

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